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ABSTRACT

This packet contains an instructor curriculum guide and a student reference book for a course in food science and technology. The 4-unit curriculum contains 23 lessons. The instructor's guide contains the following components of a unit of instruction: objectives, competencies, motivational techniques, teaching procedures, other activities, activity sheets, transparency masters, evaluations, answers to evaluations and activity sheets, references and teaching aids, and materials and equipment lists. Topics addressed are as follows: food preservation, food perishability, food processing, food product development, products and by-products, grading and inspection, biochemistry of foods, food safety, food deterioration, nutritional properties of foods, biotechnology, food selection, and consumer health. The student reference book contains information for each of the lessons. Performance objectives and competencies are included at the beginning of the guide as well as incorporated within each lesson. A competency profile has been provided in the front of the guide for recordkeeping. (KC)

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ED 379 455

Food Science & Technology

Instructor Guide

Student Reference

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10-0300-I

Food Science & Technology

Instructor Guide

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25 1969-94 years

In cooperation with Agricultural Education
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Vocational-Technical Education
College of Education and College of
Agriculture, Food and Natural Resources
University of Missouri-Columbia

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FOOD SCIENCE AND TECHNOLOGY

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FOREWORD

The development of the Food Science and Technology curriculum guide is the result of suggestions by the MVATA Teaching Aids Committee. The Food Science and Technology Advisory Committee suggested the topics to be included and reviewed the materials.

This four-unit curriculum contains 23 lessons. The instructor's guide includes: objectives, competencies, motivational techniques, teaching procedures, other activities, activity sheets, transparency masters, evaluations, answers to evaluations and activity sheets, references and teaching aids, and materials and equipment. Topics include: food preservation, food perishability, food processing, food product development, products and by-products, grading and inspection, food safety, food deterioration, nutritional properties of foods, biotechnology, food selection, and consumer health. One copy of the student reference is packaged with the instructor's guide. Additional copies of the student reference can be purchased separately.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, the director of Vocational Education applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

This guide incorporates the needed component parts to aid agriculture teachers in the implementation of VIMS. For ease of use, performance objectives and competencies have been included at the beginning of the guide as well as incorporated within each lesson. A competency profile has been provided in the front of the guide for convenient record keeping.

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FOOD SCIENCE AND TECHNOLOGY

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OBJECTIVES

UNIT I - PRINCIPLES OF FOOD PRESERVATION

1. The student will be able to describe factors related to food preservation.
2. The student will be able to describe factors that contribute to food deterioration.

UNIT II - FOOD PROCESSING

1. The student will be able to explain procedures used to process food safely.
2. The student will be able to describe the complexity of the development of food products.
3. The student will be able to identify products produced from different grades of raw milk.
4. The student will be able to summarize how dairy products are processed and packaged.
5. The student will be able to compare egg processing techniques to egg products.
6. The student will be able to list the products and by-products from meat animals.
7. The student will be able to describe the processing of meat animals.
8. The student will be able to explain the relationship between quality grades, inspections, and brand names in the meat industry.
9. The student will be able to identify the products of grain crops.
10. The student will be able to explain the processing of grain crops.
11. The student will be able to identify fruit, vegetable, and nut products and factors that determine quality.
12. The student will be able to explain how fruits, vegetables, and nuts are processed.

UNIT III - THE BIOCHEMISTRY OF FOODS

1. The student will be able to identify the factors that affect food safety and quality.
2. The student will be able to describe problems resulting from food deterioration.
3. The student will be able to describe the nutritional properties of foods.
4. The student will be able to describe how processing techniques influence the nutritional value of food.
5. The student will be able to describe the role of biotechnology in the food industry.

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

1. The student will be able to describe the factors that affect consumer choices of food.
2. The student will be able to interpret a food label.
3. The student will be able to compare the nutritional value of beverages.
4. The student will be able to describe the relationship between diet and health.

FOOD SCIENCE AND TECHNOLOGY

COMPETENCIES

UNIT I - PRINCIPLES OF FOOD PRESERVATION

1. Describe factors related to food preservation.
2. Describe factors that contribute to food deterioration.

UNIT II - FOOD PROCESSING

1. Explain procedures used to process food safely.
2. Describe the complexity of the development of food products.
3. Identify products produced from different grades of raw milk.
4. Summarize how dairy products are processed and packaged.
5. Compare egg processing techniques to egg products.
6. List the products and by-products from meat animals.
7. Describe the processing of meat animals.
8. Explain the relationship between quality grades, inspections, and brand names in the meat industry.
9. Identify the products of grain crops.
10. Explain the processing of grain crops.
11. Identify fruit, vegetable, and nut products and factors that determine quality.
12. Explain how fruits, vegetables, and nuts are processed.

UNIT III - THE BIOCHEMISTRY OF FOODS

1. Identify the factors that affect food safety and quality.
2. Describe problems resulting from food deterioration.
3. Describe the nutritional properties of foods.
4. Describe how processing techniques influence the nutritional value of food.
5. Describe the role of biotechnology in the food industry.

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

1. Describe the factors that affect consumer choices of food.
2. Interpret a food label.
3. Compare the nutritional value of beverages.
4. Describe the relationship between diet and health.

FOOD SCIENCE AND TECHNOLOGY

REFERENCES AND TEACHING AIDS

1. Student Reference

    a. Phillip R. Martin, *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994.

2. Teacher Resources

UNIT I - PRINCIPLES OF FOOD PRESERVATION

a. Books, pamphlets, etc.

1) *Advanced Food Science and Nutrition.* Texas Tech University: Home Economics Curriculum Center, 1988.

2) *Food Technology.* Instructional Materials Service, College Station, TX: Texas A & M, 1990.

3) Frick, Marty. *Food Science, Safety and Nutrition.* The National Council for Agricultural Education, 1993.

4) Gaman, P.M.; K.B. Sherrington. *The Science of Food: An Introduction to Food Science, Nutrition and Microbiology.* 3rd ed. Elmsford, NY: Pergamon Press, Inc., 1990.

5) Mehas, Kay; Sharon Rodgers. *Food Science and You.* 1st ed. Mission Hills, CA: Glencoe Publishing, 1989.

6) Tortora, Gerard J.; Berdell R. Franke; Christine L. Case. *Microbiology: An Introduction.* 1st ed. Menlo Park, CA: The Benjamin/Cummings Publishing Co, 1982.

b. Audiovisuals

1) "Careers in Harvested Foods"; "Dairy Products and Processing"; and "Meat, Poultry, and Fish Processing", available from Hobar.

UNIT II - FOOD PROCESSING

a. Books, pamphlets, etc.

1) Bence, Deborah L.; Claudia A. Lazok. *Guide to Good Food.* 4th ed. South Holland, IL: Goodheart-Willcox Co., 1992.

2) Campbell and Marshall. *The Science of Providing Milk for Man.* 1st ed. New York: McGraw-Hill, 1975.

3) Cotterill, Owen J.; William J. Stadelman. *Egg Science and Technology.* 2nd ed. Westport, CT: AVI Publishing Co., Inc., 1977.

4) *Eggcyclopedia.* 2nd ed. Park Ridge, IL: American Egg Board, 1989.

5) *Experiments in Food Science.* Chicago: The Institute of Food Technologists.

6) *Exploring Meat and Health.* Chicago: National Live Stock and Meat Board, 1991.

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15) Jelen, Panel. *Introduction to Food Processing.* 1st ed. Reston, VA: Prentice-Hall, 1985.

16) *Lessons on Meat.* Chicago: National Live Stock and Meat Board, 1991.

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18) Mehas, Kay; Sharon Rodgers. *Food Science and You.* 1st ed. Mission Hills, CA: Glencoe Publishing, 1989.

19) Milk Industry Foundation (M.I.F.). *Milk Facts.* Washington, DC: 1992.

20) Minnesota Turkey Research and Promotion Council. *The Turkey Foodservice Manual.* 1st ed. St. Paul, 1987.

21) Parkhurst, Carmen R.; George J. Mountney. *Poultry Meat and Egg Production.* 1st ed. New York: AVI, Van Nostrand Reinhold Co., 1988.

22) Potter, Norman N. *Food Science.* 4th Ed. Westport, CT: AVI Publishing Co. Inc., 1986.

23) Romans, Jones, Costello, Carlson, Ziegler. *The Meat We Eat.* 12th ed. Danville, IL: Interstate Printers and Publishers, 1985.

24) Schoeff, Robert W.; Tim Herrman. *U.S. Grain Grading Handbook.* Manhattan: Kansas State University, 1993.

25) Woodroof, Jasper Guy; Bor Shiun Luh. *Commercial Fruit Processing.* 2nd ed. Westport, CT: AVI Publishing, 1986.

26) Woodroof, Jasper. *Tree Nuts.* 2nd ed. Westport, CT: AVI Publishing, 1979.

b. Audiovisual

1) "Introduction to Meat Judging." (31 min.) available from IML.

c. Other

1) National Live Stock & Meat Board Marbling photos

UNIT III - THE BIOCHEMISTRY OF FOODS

a. Books, pamphlets, etc.

1) "Of the Earth: Agriculture and the New Biology," from the Monsanto Company, 800 N. Lindberg Blvd, St. Louis, MO 63169, (314) 694-1000.

2) Avery, Dennis. *US Agriculture in a Global Economy.* 1st ed. Washington, DC: US Government, 1985.

3) Bence, Deborah L.; Claudia A. Lazok. *Guide to Good Food.* 4th ed. South Holland, IL: Goodheart-Willcox Co., 1992.

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18) Potter, Norman N. *Food Science.* 4th Ed. Westport, CT: AVI Publishing Co. Inc., 1986

19) Romans, Jones, Costello, Carlson, Ziegler. *The Meat We Eat.* 12th ed. Danville, IL: Interstate Printers and Publishers, Inc., 1985.

20) Tortora, Gerard J.; Berdell R. Franke; Christine L. Case. *Microbiology: An Introduction.* 1st ed. Menlo Park, CA: The Benjamin/Cummings Publishing Co, 1982.

b. Audiovisuals

1) "The Nature of Change," and "BST: The Facts," Monsanto Publication, 800 N. Lindbergh Blvd, St. Louis, MO 63167, (314) 694-1000

c. Other

1) Bottle Biology Program, University of Wisconsin-Madison, (608) 263-5645.

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

a. Books, pamphlets, etc.

1) "A Guide to the Meat Department" from the Beef Industry Council, 444 N. Michigan Ave., Chicago, IL 60611, (312)467-5520.

2) "A Legitimate Beef," Pitman-Moore, Inc. 421 E. Hawley St., Mundelein, IL 60060, (800)541-7459.

3) Bence, Deborah L.; Claudia A. Lazok. *Guide to Good Food.* 4th ed. South Holland, IL: Goodheart-Willcox Co., 1992.

4) Campbell and Marshall *The Science of Providing Milk for Man.* 1st ed. New York: McGraw-Hill, 1975.

5) Curtis, Helena. *Biology.* 4th ed. New York: Worth Publishers, 1983.

6) *Exploring Meat and Health.* Chicago: National Live Stock and Meat Board, 1991.

7) *Focus on Food Labeling.* An FDA Consumer Special Report. Rockville, MD: Food and Drug Administration, May, 1993.

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10) Kowtaluk, Helen; Alice O. Kopan. *Food for Today.* 4th ed. Misson Hills, CA: Glencoe, 1990.

11) *Lessons on Meat.* Chicago: National Live Stock and Meat Board, 1991.

12) Mehas, Kay; Sharon Rodgers. *Food Science and You.* 2nd ed. New York: Glencoe, 1994.

13) Mehas, Kay; Sharon Rodgers. *Food Science and You.* 1st ed. Mission Hills, CA: Glencoe Publishing, 1989.

14) Potter, Norman N. *Food Science.* 4th Ed. Westport, CT: AVI Publishing Co. Inc.,

b. Audiovisuals

1) "The Dairy Plant," available from Creative Educational Video (CEV).

FOOD SCIENCE AND TECHNOLOGY

MATERIALS AND EQUIPMENT FOR ACTIVITY SHEETS (LABORATORY EXERCISES)

UNIT I - PRINCIPLES OF FOOD PRESERVATION

Unit I, Lesson 1

AS 1.1 Beef sirloin, freezer space, plastic wrap, freezer foil, freezer paper, plastic freezer bags, pyrex bowl with lid, plastic or freeze plate, microscope

AS 1.2 Plastic jars and lids, aluminum foil, corn chips, graph paper, jar labels or masking tape

Unit I, Lesson 2

AS 2.1 Part A Dialysis tubing (plastic sandwich bags or sausage casing), starch, iodine, water, beakers, string

Part B Eggs, vinegar, salt, corn syrup, beakers, zip-lock bags

AS 2.2 Petri dish or film with sterile nutrient agar, Scotch tape and masking tape, cotton swabs, marking pens, inoculation sources (coin, fork, etc.)

UNIT II - FOOD PROCESSING

Unit II, Lesson 1

AS 1.1 Parts A & B fruits or vegetables, sharp knife, dehydrator or standard oven, scale, labels

Unit II, Lesson 2

AS 2.1 Soybeans, water, blender, cheesecloth, cooking pot, sugar, salt

Unit II, Lesson 3

AS 3.1 Cultured buttermilk, pasteurized/homogenized milk, silage, salt, garlic salt or fresh onion, flasks or containers with lids and able to hold 500 ml or 1 pint, Erlenmeyer flask fitted with a one-hole rubber stopper, 15-inch (40 cm) hose, tripod or rings and wire gauze, Bunsen burner, fluorescent lamp without cover or shield, 4 oz. cups

Unit II, Lesson 4

AS 4.1 Raw milk or pasteurized milk with cultured buttermilk added, double boiler, heat source, 5-10 ml sterile pipets, screw cap test tubes, test tube racks, candy thermometers, ice bath, refrigerator, litmus solution, stirring rods, eye droppers, timer or watch

AS 4.2 Double boiler, candy thermometer, container for yogurt (glass, crockery, food-grade plastic or stainless steel) or individual custard cups or jelly jars with lids, large spoon, large bowl, aluminum foil or plastic wrap if no lids for containers, incubator, milk (whole, low-fat, skim or reconstituted nonfat dry milk), nonfat dry milk powder, cultured yogurt, sugar or honey (optional), unflavored gelatin (for thick, firm yogurt only)

Unit II, Lesson 5

AS 5.1 Aged eggs, candling device, fresh eggs, egg cartons, break-out tray or paper plate, ruler

Unit II, Lesson 6

AS 6.1 Whole chicken, sharp knife, cutting board, freezer bags, scales

AS 6.2 70-80 percent lean pork, salt, nonfat dry milk, water, black pepper, mace spice, coriander spice, hot mustard, meat grinder, blender, cellulose casings, stuffer (optional), stove or smoker, scale

Unit II, Lesson 9

AS 9.1 Dry soybeans, water, vegetable oil, deep fat fryer, salt, paper towels

AS 9.2 Snack food labels

Unit II, Lesson 10

AS 10.1 Wheat, barley, rye, oats, stone-wheel grinder, bowl, scales

Unit II, Lesson 11

AS 11.1 Raw nuts (pecans, walnuts, almonds, etc), nut grinder, rolling pin, plastic bags, knife, water, small pan, salt

Unit II, Lesson 12

AS 12.1 Fresh fruits or vegetables, vinegar, lemon juice, Fruit Fresh®, beakers or wide-mouth jars, tongs, paper towels, water

UNIT III - THE BIOCHEMISTRY OF FOODS

Unit III, Lesson 1

AS 1.1 Ground beef, scale, sodium nitrate, beakers, plastic bags, wax paper, refrigerator, stove or hot plate, pan for steaming, labels or masking tape

Unit III, Lesson 3

AS 3.1 Lab aprons, safety glasses, 15 foods divided into 6 small amounts (small raw potato, rice kernels, cube cheese, etc.), Lugol's iodine with dropper, biuret solution, benedict's solution, source of gas flame, eyedropper, paring knife, cutting board, heavy duty aluminum foil, brown paper, paper cups, paper plates, tongs or tweezers, graduated cylinder, beakers, stirring rod, pipette, test tubes, test tube holder, distilled water, cornstarch, aluminum foil pie tin or shaped foil container

Unit III, Lesson 4

AS 4.1	Blender, knife, scale, cheesecloth or filter paper (a coffee filter will work, but may be a little slow), hot plate or stove, microwave, 1 - 200-ml beaker or other heat-resistant container (1 cup Pyrex measuring cup will work in the microwave), 6 - 150-ml beakers (clear disposable plastic drink cups work well), 60 grams of 2 different kinds of fresh vegetables (green beans, broccoli, potato, tomato, etc.), water, 6 test tubes, eyedropper, Indolphenol blue dye, test tube rack, labels (masking tape will work), hotpads

Unit III, Lesson 5

AS 5.1	Thermometer, skim milk, double boiler, hot plate, cups, plastic spoons and knives, safety glasses, rennet solution, water

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

Unit IV, Lesson 1

AS 1.1	4 snack foods (potato chips, pretzels, banana chips, sun chips, corn chips, etc.) serving bowls, scale

Unit IV, Lesson 2

AS 2.1	Food labels from foods consumed in one day, calculator, a nutrition reference
AS 2.2	Food labels

Unit IV, Lesson 3

AS 3.1	Whole and skim milk; two brands of orange juice, soda, and coffee; indophenol blue dye; test tubes; test tube rack; eyedropper; labels or masking tape, calibrated measuring beaker, beakers, distilled water

FOOD SCIENCE AND TECHNOLOGY

CROSS REFERENCE TABLE

Competencies for Food Science and Technology	Missouri Core Competencies and Key Skills for Science
UNIT I - PRINCIPLES OF FOOD PRESERVATION	
1. Describe factors related to food preservation.	9D-6: Identify the control, the dependent, and the independent variables in an experiment. 9D-5: Describe the relationship between technologies which improve our lives and the environmental problems that can result from them.
2. Describe factors that contribute to food deterioration.	9D-6: Identify the control, the dependent, and the independent variables in an experiment. 10C-5: Identify the variables and controls in a laboratory experiment involving osmosis and reach a conclusion from the given data. 10E-1: Compare and contrast organic and inorganic compounds.
UNIT II - FOOD PROCESSING	
1. Explain procedures used to process food safely.	10C-5: Identify the variables and controls in a laboratory experiment involving osmosis and reach a conclusion from the given data.
2. Describe the complexity of development of food products.	
3. Identify products produced from different grades of raw milk.	
4. Summarize how dairy products are processed and packaged.	9D-6: Identify the control, the dependent, and the independent variables in an experiment. 9E-5: Identify the basic and acidic ranges and the neutral point on the pH scale.
5. Compare egg processing techniques to egg products.	
6. List the products and by-products from meat animals.	
7. Describe the processing of meat animals.	
8. Explain the relationship between quality grades, inspections, and brand names in the meat industry.	
9. Identify the products of grain crops.	
10. Explain the processing of grain crops.	

Competencies for Food Science and Technology	Missouri Core Competencies and Key Skills for Science
11. Identify fruit, vegetable, and nut products and factors that determine quality.	
12. Explain how fruits, vegetables, and nuts are processed.	9D-5: Describe the relationship between technologies which improve our lives and the environmental problems that can result from them. 9D-6: Identify the control, dependent, and the independent variables in an experiment.
UNIT III - THE BIOCHEMISTRY OF FOODS	
1. Identify the factors that affect food safety and quality.	9D-5: Describe the relationships between technologies which improve our lives and the environmental problems that can result from them. 10L-5: Identify the pros and cons of an environmental issue, take a position, and support.
2. Describe problems resulting from food deterioration.	
3. Describe the nutritional properties of foods.	
4. Describe how processing techniques influence the nutritional value of food.	
5. Describe the role of biotechnology in the food industry.	9D-5: Describe the relationship between technologies which improve our lives and the environmental problems that can result from them. 10D-1: Describe general ways in which human activities affect environmental quality.
UNIT IV - FOOD SELECTION AND CONSUMER HEALTH	
1. Describe the factors that affect consumer choices of food.	
2. Interpret a food label.	
3. Compare the nutritional value of beverages.	
4. Describe the relationship between diet and health.	

FOOD SCIENCE AND TECHNOLOGY

TEACHING CALENDAR

	Periods for Classroom Instruction	Length for Activity Sheets (AS)	
Unit I, Lesson 1	2	AS 1.1	20 min. for day 1 30 min. for day 30
		AS 1.2	30 min. for set up 10 min. for days 3, 5, 7, and 9
Unit I, Lesson 2	2	AS 2.1	1 class period for part A 1 class period for part B
		AS 2.2	3 class periods
Unit II, Lesson 1	2	AS 1.1	1.5 class periods for part A 1 class period for part B
		AS 1.2	Take-home activity
Unit II, Lesson 2	2	AS 2.1	2 class periods
Unit II, Lesson 3	2	AS 3.1	Advance preparation by instructor 1 class period to complete lab
Unit II, Lesson 4	3	AS 4.1	Advance preparation by instructor 2 class periods to set up lab 10 min. for 10 days thereafter
		AS 4.2	2 class periods 4 hours for incubation time
Unit II, Lesson 5	2	AS 5.1	30 min.
Unit II, Lesson 6	2	AS 6.1	2 class periods
		AS 6.2	2 class periods
Unit II, Lesson 7	3	No activity	
Unit II, Lesson 8	2	No activity	
Unit II, Lesson 9	2	AS 9.1	Overnight soak 1 hour dry time 1 class period
		AS 9.2	Take-home activity
Unit II, Lesson 10	1.5	AS 10.1	1 class period
Unit II, Lesson 11	2	AS 11.1	1 class period
Unit II, Lesson 12	1	AS 12.1	2 class periods

	Periods for Classroom Instruction	Length for Activity Sheets (AS)	
Unit III, Lesson 1	2	AS 1.1	2 class periods
		AS 1.2	Take-home activity
		AS 1.3	10 min.
Unit III, Lesson 2	2	No activity	
Unit III, Lesson 3	3	AS 3.1	2 class periods
Unit III, Lesson 4	2	AS 4.1	1 class period
Unit III, Lesson 5	2	AS 5.1	1 class period
Unit IV, Lesson 1	2	AS 1.1	20 min.
Unit IV, Lesson 2	1	AS 2.1	30 min.
		AS 2.2	10 min.
Unit IV, Lesson 3	1	AS 3.1	1 class period
Unit IV, Lesson 4	2	No activity	

Food Science and Technology

Directions: Evaluate the student by checking the appropriate number or letter to indicate the degree of competency. The rating for each task should reflect employability readiness rather than the grades given in class.

Rating Scale: **3 Mastered** - can work independently with no supervision
2 Requires Supervision - can perform job completely with limited supervision
1 Not Mastered - requires instruction and close supervision
N No Exposure - no experience or knowledge in this area

3	2	1	N	
▨	▨	▨	▨	**UNIT I - PRINCIPLES OF FOOD PRESERVATION**
				1. Describe factors related to food preservation.
				2. Describe factors that contribute to food deterioration.
▨	▨	▨	▨	**UNIT II - FOOD PROCESSING**
				1. Explain procedures used to process food safely.
				2. Describe the complexity of development of food products.
				3. Identify products produced from different grades of raw milk.
				4. Summarize how dairy products are processed and packaged.
				5. Compare egg processing techniques to egg products.
				6. List the products and by-products from meat animals.
				7. Describe the processing of meat animals.
				8. Explain the relationship between quality grades, inspections, and brand names in the meat industry.
				9. Identify the products of grain crops.
				10. Explain the processing of grain crops.
				11. Identify fruit, vegetable, and nut products and factors that determine quality.
				12. Explain how fruits, vegetables, and nuts are processed.
▨	▨	▨	▨	**UNIT III - THE BIOCHEMISTRY OF FOODS**
				1. Identify the factors that affect food safety and quality.
				2. Describe problems resulting from food deterioration.
				3. Describe the nutritional properties of foods.
				4. Describe how processing techniques influence the nutritional value of food.
				5. Describe the role of biotechnology in the food industry.
▨	▨	▨	▨	**UNIT IV - FOOD SELECTION AND CONSUMER HEALTH**
				1. Describe the factors that affect consumer choices of food.
				2. Interpret a food label.
				3. Compare the nutritional value of beverages.
				4. Describe the relationship between diet and health.

Food Science and Technology

Student Names															
▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	**UNIT I - PRINCIPLES OF FOOD PRESERVATION**
															1. Describe factors related to food preservation.
															2. Describe factors that contribute to food deterioration.
▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	**UNIT II - FOOD PROCESSING**
															1. Explain procedures used to process food safely.
															2. Describe the complexity of development of food products.
															3. Identify products produced from different grades of raw milk.
															4. Summarize how dairy products are processed and packaged.
															5. Compare egg processing techniques to egg products.
															6. List the products and by-products from meat animals.
															7. Describe the processing of meat animals.
															8. Explain the relationship between quality grades, inspections, and brand names in the meat industry.
															9. Identify the products of grain crops.
															10. Explain the processing of grain crops.
															11. Identify fruit, vegetable, and nut products and factors that determine quality.
															12. Explain how fruits, vegetables, and nuts are processed.

Student Names

UNIT III - THE BIOCHEMISTRY OF FOODS

1. Identify the factors that affect food safety and quality.
2. Describe problems resulting from food deterioration.
3. Describe the nutritional properties of foods.
4. Describe how processing techniques influence the nutritional value of food.
5. Describe the role of biotechnology in the food industry.

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

1. Describe the factors that affect consumer choices of food.
2. Interpret a food label.
3. Compare the nutritional value of beverages.
4. Describe the relationship between diet and health.

UNIT I - PRINCIPLES OF FOOD PRESERVATION

Lesson 1: Introduction to Food Preservation

Objective: The student will be able to describe factors related to food preservation.

Study Questions

1. **Why are foods preserved?**
2. **Why is food preservation important?**
3. **What techniques can be used to preserve food?**
4. **What are the causes of food deterioration?**
5. **How does time and the type of storage affect food quality?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit I.
2. Transparency Master
    - a) TM 1.1: Approximate Storage Life of Frozen Foods
3. Activity Sheets
    - a) AS 1.1: Effects of Packaging Material in Maintaining Meat Quality
    - b) AS 1.2: Effects of Light on Food Flavor

UNIT I - PRINCIPLES OF FOOD PRESERVATION

Lesson 1: Introduction to Food Preservation

TEACHING PROCEDURES

A. Introduction

Give an overview of this unit and a sample of the activities.

B. Motivation

1. Ask students to explain what they think the saying "You're not worth your salt" means. Salt has always been a very valuable commodity: used as a flavoring agent and as a preservative. Since it was so valuable, it was a source of payment for hired labor. If Jack Worker was lazy or inefficient, thus overpaid, he may have been called a worker not worth his salt.

2. Ask students if they know where the term "Uncle Sam" originated. The term "Uncle Sam" originated during the War of 1812. Pork was shipped in barrels that were stamped with the letters "U.S." and "Sam Wilson," the name of the meat packer. Soldiers referred to the meat as Uncle Sam's meat.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss with students why there is a science of food. Emphasize how food science and technology cover all phases of food production from production/handling to processing/preserving, packaging, distribution, marketing, and consumption. In the United States, an adequate food supply exists because of suitable natural resources, a favorable and diverse climate, educated producers/processors, and the application of science and technology. However, food is a perishable commodity and must be preserved.

   Why are foods preserved?

   a) To ensure an abundant and diverse food supply throughout the year
   b) To prevent microbial growth
   c) To maintain the taste and texture of food
   d) To provide food products in a more convenient form

2. Discuss the historical significance of food preservation and how it will be useful in the future. Food has always been a basic necessity for life. From the beginning of time, humans have fished, gathered, hunted, cultivated the soil, and raised animals for food. An adequate food supply, or lack of one, has contributed to the rise and fall of many nations. Even today, starvation and malnutrition are major problems in many countries. How will your future be affected by an adequate food supply? What preservation techniques may be expanded or developed in the future?

   Why is food preservation important?

   a) Food preservation is necessary for life unless fresh food is gathered on a daily basis.

b) Historically
    1) Early civilizations developed in areas where food was plentiful.
    2) Before "sun-drying", fruits and vegetables were eaten seasonally.
    3) Before salt curing, meat was preserved only for a minimal length of time.
    4) Napoleon was successful largely because he provided a healthy diet for his soldiers. He suffered his greatest defeat when it became difficult to feed his troops.
    5) Early Asians preserved food with spices and sugar.
    6) American pioneers depended on salted, pickled and smoked meat and fish and dried beans.
        (a) Meat was processed/preserved in winter months.
        (b) Sausages were cooked and covered with melted lard.
        (c) Milk, eggs, and butter were kept in springhouses.
        (d) Fruits and vegetables were preserved in root cellars, by burying, or by drying.
    7) The railroads in the 1830's and the refrigeration car in the 1880's brought considerable changes.

c) Future
    1) World population continues to grow while productive acreage declines. Longer preservation techniques are needed.
    2) Convenience may dictate processing, so preservation technology will need to keep current.
    3) Energy expense of irradiation, refrigeration, and freezing may be reduced by new technology.
    4) Medical use of some types of chemotherapy alters the immune system, which requires that meals be sterilized by irradiation.

3. Discuss techniques that can be used to preserve food by controlling microbes and enzymes. Have students work in groups to begin complete AS 1.1. On day 30, the activity will be completed.

What techniques can be used to preserve food?

a) Heat
    1) Pasteurization
    2) Sterilization
b) Cold
    1) Refrigeration
    2) Freezing
c) Drying
    1) Dehydration
    2) Freeze-drying
d) Irradiation
e) Packaging
    1) Vacuum
    2) Modified atmosphere/controlled atmosphere
f) Additives
    1) Salt
    2) Smoke
    3) Sugar
    4) Spices
    5) Others
    6) Acid
g) Fermentation - 'natural' additives

    1) Acid
    2) Alcohol

4. Discuss the causes of food deterioration. Food is subject to physical, chemical, and biological deterioration. In practical terms, food is actually undergoing deterioration from the time it is harvested or slaughtered. The critical question is: How slow or how rapid is this process? Have students complete AS 1.2.

   What are the causes of food deterioration?

   a) Microorganisms
   b) Natural food enzymes
   c) Pests
      1) Insects
      2) Rodents
      3) Birds
      4) Parasites
   d) Other factors
      1) Temperature abuse (warm and cold)
      2) Light
      3) Moisture
      4) Oxygen

5. Discuss how the time and type of storage affect food quality. At best, the quality of fruits, vegetables, nuts, meat, grain, dairy products, and eggs is only maintained (not improved) in storage. In most cases, the quality actually suffers. There are several critical factors that determine time of storage. Use TM 1.1.

   How does time and the type of storage affect food quality?

   a) Quality of raw food product
   b) Food handling immediately after harvest - Was it cleaned and chilled rapidly? In the case of fruits and vegetables, were refrigeration units placed in the fields or was the produce transported to the units at a later time? Sweet corn will metabolize its own sugar following harvest. If cooled to 32°F, only 10 percent of its sugars will be converted to starch in one day. At 68°F, 25 percent may be converted in the same time period. Portable hydrocoolers can jet spray freshly picked fruits and vegetables with cold water that may contain a germicide to inactivate surface microbes. The products would then be placed in a refrigeration unit. The use of cold N_2 will facilitate evaporative cooling. Animal carcasses must be lowered to an internal temperature of 36°F within 24 hours of slaughter.
   c) Relative humidity - A critical factor in long-term food storage is air moisture, or relative humidity (RH) during storage and handling.
      1) Most microorganisms thrive in moist environments. Thus, to inhibit their growth and multiplication, RH levels must be controlled.
      2) Environments that are too dry will dehydrate the product unintentionally and lower its quality.
         (a) Beef stored at less than 90 percent RH dries out. If RH is between 90-98 percent, the beef will mold. At higher levels bacteria cause spoilage.
         (b) Cheeses are wrapped in film or coated to inhibit mold growth.
      3) Meat tissue may be covered with a film of plastic to decrease moisture loss.
      4) Eggs may be coated with a thin film of mineral oil to maintain moisture level.

d) Storage temperature - Refrigeration, or cool storage, refers to temperatures in the range of 30°-61°F. Freezing refers to temperatures below 30°F.
   1) Pure water freezes at 32°F, while most foods will not begin to freeze until 30°F is achieved.
   2) Refrigeration may preserve food for days or weeks.
   3) Freezing can preserve food for months or years.
   4) Neither freezing nor refrigeration completely destroys all microbes. Once food is thawed, rapid multiplication is possible.
   5) Refrigeration is one of the gentlest methods of food storage in terms of maintaining taste, nutritional value, and texture.
   6) Refrigeration accelerates the staling of breads.

e) Additional processing - For long-term storage of food, heat, dehydration, irradiation, fermentation, or complete freezing is necessary.

F. Other activities

1. Salt/sugar cure a ham. See MU Agricultural Guide #2526, "Country Curing Hams." It is included as Appendix A.

2. Assign students to visit local grocery stores and report the type of light used in meat, fruit, vegetables, dairy, and egg counters. Determine which food products are packaged in transparent, translucent, and opaque containers. Investigate what temperature the grocery store maintains and if the relative humidity reading is monitored.

G. Conclusion

Foods are preserved for human safety, quality enhancement, convenience, and to provide a constant supply. Food preservation was important in the past, is important today, and will be important in the future. There are many techniques used to preserve food that control microbes and enzymatic activity. Without these techniques, physical, chemical, and biological deterioration are possible. Food quality is also influenced by the time and type of storage.

H. Competency

Describe factors related to food preservation.

Related Missouri Core Competencies and Key Skills:

9D-6: Identify the control, the dependent, and the independent variables in an experiment.
9D-5: Describe the relationship between technologies which improve our lives and the environmental problems that can result from them.

I. Answers to Evaluation

1. b
2. d
3. c
4. c
5. a
6. d

7. To insure an abundant, safe, diverse food supply. To enhance its taste and texture and for convenience.

8. Early American colonists would slaughter animals in the cold months. Their meat would be salted, pickled, or smoked. Sausage was cooked and covered with lard. Fruits and vegetables were dried, buried, or stored in root cellars. Fresh milk, butter, and eggs were kept cool in springhouses.

9. Heat denatures proteins, breaks emulsions, dries food and can destroy vitamins. Enzymatic and non-enzymatic reactions increase as heat is increased.

10. Too much moisture can cause lumping, crystallization, and stickiness. Too little moisture can cause dehydration and staleness.

11. Bacteria, mold, yeast.

12. Except for certain fruits and vegetables, the sooner a food product is cooled to 32°-40°F, the longer it can be stored. The conversion of sugars to starch is reduced by cooling.

13. Because microorganisms require moisture for survival, relative humidity levels are critical to food storage. Careful control of RH is vital. Too high = spoilage; too low = dehydration.

J. Answer to Activity Sheets

AS 1.1

1. They make a difference in food quality.

2. Class discretion

3. Light barrier; O_2 barrier

4. Class discretion

5. Tissue darkens and stiffens

6. Proper sealing and taping

7. Use packaging that is opaque and seals against O_2.

AS 1.2

1. Class discretion

2. Class discretion

3. Opaque containers reduces oxidation and rancidity.

4. Oxidation and rancidity

5. Class discretion; may include sealed bags, sealed tubes, foil bags

6. Class discretion

7. Class discretion

UNIT I - PRINCIPLES OF FOOD PRESERVATION Name________________

Lesson 1: Introduction to Food Preservation Date________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. The removal of moisture in a food product is called:

   a. Freezing.
   b. Dehydrating.
   c. Irradiating.
   d. Sterilizing.

2. Removing all the oxygen from a food package is called:

   a. Sterilizing.
   b. Freeze drying.
   c. Heating.
   d. Vacuum packaging.

3. Sterilizing is applying a temperature of ______ and maintaining it for _______ minutes.

   a. 100°F, 15
   b. 180°F, 5
   c. 240°F, 15
   d. 420°F, 30

4. What are two preservation techniques that create a high osmotic pressure?

   a. Sweetening and sterilizing
   b. Salting and vacuum packaging
   c. Sweetening and salting
   d. Salting and fermenting

5. In fermentation, bacteria convert carbohydrates into:

   a. Acids and alcohol
   b. Sugars and acids
   c. Alcohol and salts
   d. Sugars and salts

6. What additives are used to preserve foods?

   a. Salt, flavorings, and oils
   b. Flavor enhancers and sugar
   c. Food coloring, sugar and flavorings
   d. Salt, spices, and sugar

Complete the following short answer questions.

7. Why is food preserved?

8. Describe the food preservation techniques used by early American colonists.

9. Describe how an increase in heat affects food preservation.

10. Compare and contrast too much moisture and too little moisture on food preservation.

11. Name three general types of microorganisms.

12. Why is refrigeration useful in food storage?

13. How does relative humidity affect food storage?

Approximate Storage Life of Frozen Foods

	Approximate Storage Life (in months unless indicated otherwise)		
	-18°C (0°F)	-12°C (10°F)	-6.7°C (20°F)
Orange juice (heated)	27	10	4
Peaches	12	<2	6 days
Strawberries	12	2.4	10 days
Cauliflower	12	2.4	10 days
Green beans	11-12	3	1
Peas	11-12	3	1
Spinach	6-7	3	21 days
Chicken (raw)	27	15 1/2	<8
Fried chicken	<3	<1	18 days
Turkey pies	>30	9 1/2	2 1/2
Beef (raw)	13-14	5	<2
Pork (raw)	10	<4	<1 1/2
Lean fish (raw)	3	<2 1/2	<1 1/2
Fat fish (raw)	2	1 1/2	24 days

Courtesy U.S. Department of Agriculture

Name ________________

Effects of Packaging Material in Maintaining Meat Quality

Objective: To examine the effects of packaging a food with a variety of common packaging materials.

Activity Length: Day 1 - 20 minutes
Day 30 - 30 minutes

Materials and Equipment:

Beef sirloin - 1/4 lb per group of students
Freezer space for about 30 days
Plastic wrap used to package beef in the store
Freezer foil
Freezer paper
Plastic freezer bags
Pyrex bowl (covered)
Plastic or freezer plate (to be used for the "no wrap" meat)
Microscope

Procedure:

1. Cut the beef into 6 equal pieces.

2. Wrap each piece of beef with one of the packaging materials. Label each piece of beef with the group's name and the kind of packaging and place it in the freezer.

    a. Plastic wrap used to package beef at store
    b. Freezer foil
    c. Freezer paper
    d. Plastic freezer bag
    e. Pyrex bowl (covered)
    f. "No wrap" on plastic or freezer plate

3. Store the meat for 30 days and then thaw it.

4. Observe the meat as it thaws. Observe it under a microscope. The meat can be thawed in a microwave, except when foil is used.

5. Compare each of the pieces for general appearance: color, odor, the amount of drip (free water and juice coming from the meat), freezer burn, frost, and freshness. Evaluate each piece of beef on a scale of 1-5 with 5 being excellent and 1 being unacceptable. Record your answers on Table 1.1.

6. Evaluate the packaging methods between each of the groups.

Table 1.1

	Color	Odor	Amount of drip	Freezer burn	Frost	Freshness
Plastic wrap						
Freezer foil						
Freezer paper						
Plastic freezer bags						
Pyrex bowl						
No wrap						

(Rating Scale: 1 = unacceptable, 5 = excellent)

Key Questions:

1. What did you discover about packaging materials?

2. Which packaging materials are acceptable for freezing meat?

3. What qualities of the packaging materials allow them to preserve beef meat at an acceptable level?

4. What material would you not use to package beef in for freezer storage?

5. What does freezer burn look like?

6. What additional steps should you use to prepare beef to be frozen?

7. Based on your discoveries, what recommendations would you make for packing beef into freezer containers?

Adapted from: Frick, Marty. *Food Science, Safety and Nutrition.* The National Council for Agricultural Education, 1993.

Name ________________

Effects of Light on Food Flavor

Objective: To observe and sample the effect light has on the flavor of corn chips stored in different ways for various periods of time.

Activity Length: 30 minutes to set up, 10 minutes each on days 3, 5, 7, and 9

Background Information:

Food is placed in packaging for a variety of reasons. This experiment will help you understand the effect light has on food quality. The packaging selected by the processor is determined by the protecting quality (from microorganisms), its ability to protect the food from damage, and its ability to preserve or maintain the food over time. As you are probably aware, fat oxidizes and becomes rancid (spoiled), causing undesirable flavors and odors. These flavors can develop in high fat foods, such as peanut butter, corn chips, or nuts. The method by which these foods are packaged can influence whether they become rancid or not. Light and oxygen can accelerate the process.

Materials and Equipment:

3 clear plastic jars and lids per group
aluminum foil
1-2 bags corn chips
graph paper
jar labels (masking tape)

Procedure:

1. Obtain three clear glass or plastic jars with lids (for each student or group of students). Label jars 1, 2, and 3. Wrap jar #1 with a light preventing layer (aluminum foil or construction paper). Place this protecting layer so that no light enters the jar.

2. Place equal amounts of corn chips (about 1/3 cup) in each jar. Smell and taste one chip from each jar. Record your opinion on Day 1 of Table 1.1. Place the lids on the jars.

3. Label the jars with your name, the date, and class period. Place the jars in a location that will not get extreme heat. Place jar #1 (the control) near jars #2 and #3. Place jar #2 near a window in order that it will receive sunlight. Place jar #3 under a continuous light source.

4. Observe, smell and taste corn chips from the jars every other day for 10 days (5 total samples). Rate the flavor of the chips on the following five-point scale. Rate the flavor based on how the chips originally tasted.

5. Make a graph of the data you collect as a result of this experiment. Chart the data on the flavor of the corn chips versus the storage time, for all three samples. The flavor should be on the side of the graph (y-axis) and the days should be on the bottom (x-axis). Use a different color pen or marker to show taste ratings and order ratings.

Scale:

1 = The Worst
2 = Bad Flavor
3 = OK (no opinion)
4 = Good Flavor
5 = The Best

Chart

Day	Rating of chips protected from light		Rating of chips exposed to sunlight		Rating of chips exposed to continuous light	
	taste	odor	taste	odor	taste	odor
1						
3						
5						
7						
9						

Key Questions:

1. When did the flavor of the corn chips begin to deteriorate?

2. When did you first detect a difference in the odor of the food?

3. What effect did wrapping the jar have on the quality of the chips?

4. What type of reactions occurred with the chips that caused them to deteriorate?

5. List three types of containers that food processors use to retain the quality of chips?

6. Do you see corn chips or potato chips or other types of high fat products being marketed which do not follow these rules? Why?

7. What types of precautions could chip processors use in the design of packages to better maintain the product over time?

Adapted from: Frick, Marty. *Food Science, Safety and Nutrition.* The National Council for Agricultural Education, 1993 and Mehas, Kay; Sharon Rodgers. *Food Science and You.* Peoria, IL: Glencoe, Publishing, 1989.

UNIT I - PRINCIPLES OF FOOD PRESERVATION

Lesson 2: Food Perishability

Objective: The student will be able to describe factors that contribute to food deterioration.

Study Questions:

1. **Which food characteristics influence deterioration rate?**
2. **How does acidity/alkalinity influence the perishability of food products?**
3. **What is the relationship between water, salt, sugar, and osmotic pressure as they relate to food preservation?**
4. **How does microbial activity affect food preservation?**
5. **How are chemical preservatives used in foods?**
6. **How does the ambient environment affect the perishability of foods?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit I.
2. Transparency Master
    a) TM 2.1: Food Additives Used as Preservatives
3. Activity Sheets
    a) AS 2.1: Osmosis and Diffusion Across a Semi-permeable Membrane
    b) AS 2.2: Bacteria Are Found Everywhere

UNIT I - PRINCIPLES OF FOOD PRESERVATION

Lesson 2: Food Perishability

TEACHING PROCEDURES

A. Review

Ask students to summarize their conclusions from the previous lesson and describe how these conclusions relate to this lesson.

B. Motivation

1. Place one green banana in plastic bag. Leave one green out. Immature produce can be ripened more quickly if sealed in an air-tight bag. Relate ethylene gas to natural vegetable/fruit hormones and demonstrate its ripening characteristic on sealed produce. Fruits and vegetables produce several hormones. A product of hormonal activity, not a hormone itself, ethylene is a natural ripening agent. Check the bananas the next class period to see how they have ripened.

2. Rank the following food items in the order they would deteriorate at room temperature considering they were freshly packaged the day you purchased them: honey, hot dogs, hamburger, tomato, corn flakes, milk.

3. On a survival trip to the Teton mountains in December, which of the following foods would you take: butter, oranges, dried beans, bacon, soda, potatoes, chocolate, watermelon?

4. To observe deterioration, leave a glass of milk out overnight. Examine milk.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss which food characteristics influence deterioration rate.

   Which food characteristics influence deterioration rate?

   a) pH
   b) Moisture (water activity level)
   c) Temperature of the product
   d) Oxygen level
   e) Physical characteristics

2. Discuss how the degree of acidity/alkalinity influences the perishability of food products.

   How does acidity/alkalinity influence the perishability of food products?

   a) The more acidic, or lower pH the food is, the slower the deterioration rate.
   b) Bacterial growth generally favors a pH near neutral (7.0).

3. Discuss the relationship between water, salt, sugar, and osmotic pressure as they relate to food preservation. AS 2.1

   What is the relationship between water, salt, sugar, and osmotic pressure as they relate to food preservation?

   a) When sugar or salt is added, the osmotic pressure increases and the water activity (Aw) decreases.
   b) When the osmotic pressure is high enough to draw water away from microbial cells, or prevent normal diffusion of water into microbial cells, the cytoplasm within the microbial cell dehydrates.

4. Discuss how microbial activity affects food preservation.

   How does microbial activity affect food preservation?

   a) Physical changes - more apparent than chemical changes
      1) Slime formation, undesirable odors and flavors, color changes caused by aerobic bacteria and yeasts
      2) Sticky surface caused by aerobic molds
   b) Chemical changes - Proteins, lipids, carbohydrates, and other complex molecules are degraded into simpler molecules.

5. Discuss how chemical preservatives are used in foods. Use TM 2.1 during the discussion.

   How are chemical preservatives used in foods?

   Chemical preservatives, often called additives, are substances added to food to improve appearance, flavor, texture, or storage properties. They generally work by acting directly on biological and chemical reactions that decrease food quality.

6. Discuss how the ambient environment affect the preservation of foods.

   How does the ambient environment affect the perishability of foods?

   a) The absence of O_2 prohibits the growth of all molds and aerobic bacteria and retards cellular respiration.
   b) CO_2 and O_3 have been used in the holds of ships to curtail aerobic growth. CO_2 can cause souring due to carbonic acid formation. O_3, ozone, kills most microorganisms, but may increase rancidity in some products.
   c) Nitrogen (N_2) is used for immersion freezing and as a cooling agent to preserve foods. N_2 boils at -196°C, so liquid N is colder than this. N_2 is also used to displace O_2 in many food packages.
   d) The presence of O_2 permits aerobic bacteria, molds, yeasts, and respiration.
   e) CO_2 used to purge fermented products removes any O_2.
   f) CO_2 used in soft drink production - contributes to acidic preservative action.
   g) CO_2 levels are increased to 2-5 percent while O_2 levels are only 3 percent, the remainder N_2, used to preserve apples and other fruits. This low O_2 level retards respiration and hence deterioration rate. Normal atmosphere O_2 level is 21 percent.
   h) Use of ethylene gas speeds ripening and color development in citrus and bananas.
   i) Eggs are stored in enriched CO_2 storehouses to minimize microbial spoilage.

F. Other activities

1. Take pH readings of various food/beverage solutions: several types of soda, milk, coffee, orange juice, sauerkraut, pickles, green beans, water, egg white vs. egg yolk, etc.

2. Examine food ingredient statements on various food packages and identify chemical preservatives used. What other techniques are used to preserve the product - package, atmosphere, refrigerate after opening, etc.

G. Conclusion

Food preservation relies on a variety of factors. A product's physical characteristics, access to O_2, temperature, water activity level, and pH are all critical factors that must be managed to delay deterioration. Unless these variables are carefully monitored, microbial activity/deterioration will take place. Other controls to prevent spoilage are the use of additives and gaseous atmosphere modifications.

H. Competency

Describe factors that contribute to food deterioration.

Related Missouri Core Competencies and Key Skills

9D-6:	Identify the control, the dependent, and the independent variables in an experiment.
10C-5:	Identify the variables and controls in a laboratory experiment involving osmosis and Reach a conclusion from the given data.
10E-1:	Compare and contrast organic and inorganic compounds.

I. Answers to Evaluation

1. c
2. d
3. a
4. d
5. a
6. b
7. The dialysis tube would lose water by osmosis because the concentration of salts is greater in the salt water solution. It would collapse.
8. Increased surface area; water and nutrients are more available to microbes; O_2 is more available.
9. Acid denatures a microorganism's protein. Therefore, the greater the acid concentration, the less perishable the food product becomes. Some acids directly poison some microbes.
10. Slime formation; sticky surface; undesirable flavor and odor; color change.
11. Sodium benzoate; nitrates and nitrites; BHA; BHT; TBQH; sorbic acid, sodium and calcium propionates, chlorine compounds, ethylene oxide and ethylene formate, salt; sugar; smoke; acids; sulfer dioxide

J. Answer to Activity Sheets

AS 2.1

Part A
1. Yes
2. Iodine, the starch solution turned brown-black
3. The starch molecule is too large to move through semi-permeable membrane

Part B

1. Should be egg A
2. Egg B
3. The vinegar dissolves the shell.
4. They will absorb water, enlarge to an artificial size, and become susceptible to deterioration.
5. Instructor's discretion

AS 2.2

1. Bacteria are just one type of microorganism. Microorganisms are found everywhere, and include molds, yeasts, protozoa, viruses, and bacteria.
2. A safe rule of thumb is to: keep hot foods hot, keep cold foods cold, and keep all food preparation surfaces and equipment clean.
3. Penicillium is a mold that provides us with the antibiotic, penicillin. However, some molds produce toxins that can make us very sick. Some molds make our food look taste, or smell bad.
4. Some yeasts are used to make foods, for example, the yeast that makes bread rise or the yeast that turns the sugar in grapes to alcohol in wine.
5. Instructor's discretion.

Name ______________

Lesson 2: Food Perishability

Date ______________

EVALUATION

Circle the letter that corresponds to the best answer.

1. The ____________________________ the pH of a food item, the longer the food will keep.

   a. More constant
   b. Greater
   c. Lower
   d. Higher

2. Which of the following do all microorganisms require for survival?

   a. Temperature above 50°F
   b. Oxygen
   c. pH 5.0 or higher
   d. Moisture

3. When the level of salt is increased, the osmotic pressure ______________________ while the water activity ______________________.

   a. Increases, decreases
   b. Increases, Increases
   c. Decreases, increases
   d. Decreases, decreases

4. Microbial conversion of carbohydrates to organic acids is an example of a _________________________ change.

   a. Physical
   b. Mechanical
   c. Technical
   d. Chemical

5. What does aerobic mean?

   a. In the presence of O_2
   b. In the presence of CO_2
   c. In the absence of O_2
   d. In the absence of CO_2

6. What gas is most frequently used for immersion freezing?

   a. Carbon dioxide
   b. Nitrogen
   c. Oxygen
   d. Ozone

Complete the following short answer questions.

7. Describe what would happen if you placed a dialysis tube completely filled with pure water into a salt water solution.

8. Give two reasons why retail cuts of meat are more vulnerable to deterioration than a whole carcass.

9. Describe how acidity influences the perishability of food.

10. Name one physical change of food due to microbial activity.

11. Name three food chemical preservatives.

Food Additives Used as Preservatives

- Acetic acid
- Ascorbic acid
- Benzoic acid
- Butyl paraben
- Calcium lactate
- Calcium propionate
- Calcium sorbate
- Citric acid
- Ethylene oxide
- Heptylparaben
- Methylparaben
- Potassium propionate
- Propylparaben
- Salt
- Sugar
- Sodium benzoate
- Sodium erythorbate
- Sodium nitrate
- Sodium propionate
- Sodium sorbate
- Sorbic acid
- Sucrose
- Sulfur dioxide

Lesson 2: Food Perishability

Name __________________

Osmosis and Diffusion Across a Semi-permeable Membrane

Objective: Students will identify the variables and controls in a lab experiment involving osmosis and diffusion across a semi-permeable membrane.

Activity Length: Part A: 60 minutes
Part B: 60 minutes

Materials and Equipment:

Part A
dialysis tubing, small plastic sandwich bags, or sausage casing
0.5% starch solution (1 tsp. cornstarch to 1 cup hot water, stir well)
1.0% tincture of iodine solution (4 or 5 drops of tincture of iodine to 1 cup water, stir well)
2 - beakers

Part B
4 eggs per group
vinegar
salt
corn syrup
beakers
water

PART A: Osmosis

Procedure:

1. Obtain two beakers and two strips of dialysis tubing (small plastic sandwich bags and sausage casing may be substituted). Tie one end of tubing with string and open the other end by gently rolling the tubing between your thumb and forefinger. Fill this tube with starch solution and close the tubing. (Use a tight knot to be sure it does not leak.) Rinse the tubing under water and then submerge the bag in a beaker filled with iodine solution.

2. Prepare the second tube by filling it with iodine solution, closing the ends and rinsing under water before submerging the bag in a beaker filled with starch solution. Allow both bags to remain undisturbed for at least 30 minutes before completing your observations.

Key Questions:

1. Is there any evidence that either substance has moved through the membrane of the dialysis tubing?

2. Which molecule moves through the membrane, starch or iodine? How can you tell?

3. Why does the other molecule not move through the membrane?

PART B: Diffusion

Name ________________

Procedure:

Each group obtains four fresh eggs. Label the eggs A, B, C, and D. Measure the circumference of each egg and include in Table 1.1. Place egg A in a zip-lock bag filled 1/2 full with water. This is your control. Place egg B in a zip-lock bag filled 1/2 full with salt water. Use one tablespoon of salt per 1 cup of water. Place egg C in a zip-lock bag filled 1/2 full with corn syrup. Put egg D in vinegar solution. Allow eggs to set undisturbed for 30 minutes and then observe. Take circumference readings again and include in Table 1.1.

Table 1.1 Egg Circumference

Circumference	Egg A	Egg B	Egg C	Egg D
Before experiment				
After 30 minutes				
Percent increase or decrease				

Key Questions:

1. Which egg had the largest increase in size?

2. Did any egg shrink?

3. Why do you think an acid rinse (vinegar) is not used on eggs?

4. In egg processing, why are eggs not allowed to soak in water while cleaning?

Lesson 2: Food Perishability

Bacteria Are Found Everywhere

Objective: To recognize that microorganisms are found everywhere and can grow under favorable conditions. Students will compare and contrast organic and inorganic compounds by observing the microbes they carry.

Activity Length: Three class periods

Materials and Equipment:

Petri dish or film with sterile nutrient agar (1 per student)
Scott tape and masking tape
Cotton swabs
Inoculation sources (coin, raw meat)
Marking pens

Procedure:

1. Each student should have a petri dish (make sure that lids are not removed until you are told to remove them).

2. Select a contamination source.

3. Obtain inoculation sources from instructor.

4. Inoculate petri film with one of the following:

   Open the petri dish just before adding the contaminate.

   - hands--gently touch fingers to the agar, or gently lay your hand on the agar and remove it, or lightly trace an S pattern on the agar with your finger tip.

   - lips -- touch your lips lightly to the agar.

     NOTE: agar is nontoxic.

   - hair--remove a piece of hair from your head and gently lay it on the agar. Try to avoid touching the agar with your fingers.

   - cough--hold the plate 2-3 inches from your mouth and cough directly onto the agar.

   - coin--place a coin (not a penny, the copper will keep many microorganisms from growing) on top of the agar in the middle of the plate. Or, gently rub or roll the coin over the surface of the agar (try not to dig a hole in the agar).

   - saliva--place a clean cotton swab in your mouth and moisten it with saliva. Gently rub the moistened swab over the surface of the agar.

- raw meat--place a small piece of raw meat (i.e., ground beef) on top of the agar in the center of a plate, or gently rub the meat over the surface of the agar.
- floor--drag finger across the floor, then trace an S pattern on the agar with the same finger.
- fork--wipe the eating surface of a clean fork on the agar.
- cup--wipe the drinking surface (top of cup) on the agar.

5. Immediately close the petri dish.

6. Use scotch tape to seal the plates. (Wrap the tape around the edge of the plate.)

7. Use masking tape or marking pens to label each plate with your name and the source of bacteria. (Label plates on the bottom, write small enough that you will be able to see the bacteria once they grow.)

8. Incubate the plates upside down at 85°F. (You can incubate the plates at room temperature, but it will take longer for the microorganisms to grow.) NOTE: Keep the plates away from windows since UV light kills bacteria. You incubate them upside down so that the moisture droplets that form don't fall on the agar.

9. WASH YOUR HANDS AFTER HANDLING THE PETRI DISHES!
CAUTION: Some microorganisms on the dishes could make you sick. Always wash your hands after handling the petri dishes!!!

10. The plates will incubate for two days, but you will examine them after 24 hours.

11. Examine the plate after 48 hours.

12. Observe the number of colonies, color of colonies, shape of colonies, and any other characteristics.
NOTE: Do not remove lids from petri plates.
SAFETY NOTE: Agar plates should be autoclaved after the experiment is completed. This prevents the possible transmission of disease to anyone or anything that might come in contact with the trash. The biology instructor or local hospital may be able to help.

Key Questions:

1. What are bacteria?

2. What are three things that can be done to limit bacteria growth in the foods students prepare at home?

3. Name a type of mold that is helpful.

4. Some yeasts are used for what purpose?

5. How many colonies were found on your agar and what was their color?

Adapted from: Frick, Marty. *Food Science, Safety and Nutrition.* The National Council for Agricultural Education, 1993 and *Safe Food Preparation: It's on Your Hands.* University Extension Guide #GH1165.

UNIT II - FOOD PROCESSING

Lesson 1: Procedures Used in Processing Food

Objective: The student will be able to explain procedures used to process food safely.

Study Questions

1. **Why are foods processed?**
2. **How can foods be processed?**
3. **How is food safety assured?**
4. **What methods should be used to clean and sanitize food processing equipment?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.
2. Activity Sheets
    - a) AS 1.1: Dehydration and Rehydration
    - b) AS 1.2: Food Processing--Magic Square

UNIT II - FOOD PROCESSING

Lesson 1: Procedures Used in Processing Food

TEACHING PROCEDURES

A. Introduction

The largest segment of employment in the food business is food processing. This unit will examine the various processing techniques and related issues.

B. Motivation

1. Give each student a piece of pizza. Before they eat it, have them dissect its ingredients and chart what processes took place before it became a pizza. A frozen pizza label can be used to identify all of its ingredients.

2. Show one or all of the following eight-minute careers videos from Hobar: Careers in Harvested Foods; Dairy Products and Processing; and Meat, Poultry, and Fish Processing.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss with students why foods are processed. Food processing can be defined as any mechanical, chemical, or biological treatment to food. These processes may preserve the food or change the raw materials appearance or flavor.

Why are foods processed?

a) Processed food can be stored for longer periods of time.
b) Processing techniques slow down deterioration.
c) Processing helps guard against microbial contamination.
d) Processing can make foods more convenient, add variety, enhance flavor, and increase value (tenderization, size, weight, shape control).
e) Processing controls composition (protein, fat, moisture content).

2. Discuss with students the various ways that foods can be processed. Have students complete AS 1.1 and AS 1.2.

How can foods be processed?

a) Dehydration - the removal of water from foods: dried fruit, beef jerky
b) Fermentation - fermentation releases nutrients locked in plant cells; starch can be split into simple sugars
c) Milling - removal of chaff and all other foreign material; may be washed with water and separated by size
d) Fractionation - separate constituents (i.e., hulls, bran, germ, endosperm) from each other
e) Grinding - reducing the particle size, (e.g., ground beef, flour) - called comminution in the meat industry

f) Emulsifying - ingredients that normally would repel each other and separate are held together, or stabilized, by an emulsifying agent
g) Homogenizing - forcing milk or other liquids under high pressure through a valve which breaks large fat molecules into smaller ones
h) Hydrogenation - edible oil is converted to a semi-solid state (e.g., margarine and shortening), resulting in a product that is spreadable and resists rancidity
i) Combination - mixing of constituents back together
j) Texturization - wheat is transformed into pasta; restructured meats have been ground, flaked, or chopped and formed into steak or roast-like products
k) Chemical modification - addition of heat, enzymes, or microbes to produce a product (e.g., cider, pickles, popcorn, corn syrup)
l) Precipitating/centrifuging - separating the components based on their densities; a centrifuge speeds the process (e.g., milk casein precipitates forming the curd)
m) Extrusion - formulated dough or mash is forced through an extruder; high pressures cause the starch molecules to swell and then gel; this creates a puffing of the newly shaped product

3. Discuss with students how food safety is assured.

How is food safety assured?

a) Federal Meat Inspection Act of 1906 - provides mandatory inspection of animals, slaughtering conditions, and meat processing facilities; regulates interstate activities
b) Wholesome Meat Act of 1967 - all city and state meat regulations must meet federal standards
c) Federal Poultry Products Inspection Act of 1957 and Wholesome Poultry Products Act of 1968 - set federal standards on poultry.
d) Federal Trade Commission Act of 1938 - protects the public from false advertising in the food industry
e) Food, Drug, and Cosmetic Act of 1938 - set the basic principles of food safety and gave the FDA the power to enforce food safety measures
f) Infant Formula Act of 1980 - manufactured formulas must contain known essential nutrients at appropriate levels
g) Federal Grade Standards - uniform quality standards
h) State and Local Laws - various state and local laws usually administered by the Health Department
i) Food and Drug Administration (FDA) - assures consumers that the food they buy is safe, nutritious, and honestly represented; approves all additives before they can be used; lists over 600 ingredients that are safe and not considered additives; Generally Recognized As Safe (GRAS) e.g., sugar, table salt, cinnamon
j) USDA - monitors meat and poultry products; FDA monitors all other foods
k) USDA Grade A Pasteurized Milk Ordinance

4. Discuss the methods that should be used to clean and sanitize food processing equipment. Clean means to remove all visible filth. Sanitize refers to removing any microbial contamination.

What methods should be used to clean and sanitize food processing equipment?

a) Cleaning - removing all visible filth
    1) Hot water plus alkaline cleanser
    2) Acidic cleanser used to remove mineral deposits
b) Sanitize - Following cleaning, sanitize at 180°F with water or an approved chlorine or iodine rinse.

c) Metal equipment needs to be sprayed with an edible mineral oil to prevent rusting.

F. Other activities

1. Conduct "Bacteriological Examination of Food Equipment and Eating Utensils" experiment from *Food Science, Safety and Nutrition* by the National Council for Agricultural Education.

G. Conclusion

Food is processed, or changed mechanically, chemically, or enzymatically for a variety of reasons. Due to these reasons, several processes have been developed to provide consumers with a safe food supply. The U.S. Government, through the USDA and the FDA, regulate food safety standards. Producers and processors alike, work to deliver wholesome food to the consumer. A part of this commitment to food safety is the proper cleaning and sanitization of processing equipment.

H. Competency

Explain procedures used to process food safely.

Related Missouri Core Competencies and Key Skills:

10C-5: Identify the variables and controls in a laboratory experiment involving osmosis and reach a conclusion from the given data.

I. Answers to Evaluation

1. Any three of the following: convenience, value adding, microbial contamination guard, slows down deterioration, variety, longer storage, composition control, flavor enhancement
2. j
3. d
4. h
5. f
6. d
7. k
8. i
9. g
10. b

J. Answers to Assignment Sheets

AS 1.1

Part A
1. Longer storage, more convenient, slows microbial activity, adds value
2. More chewy, less juicy, darkened, etc.
3. Answers will vary depending on type of foods compared.
4. Certain foods would lose their palatability, water-soluble vitamins, diversity of use, etc.
5. Yes, answers will vary depending on type of foods compared.

Part B
1. Normally, no they cannot. Cells have collapsed and cell walls are broken.

AS 1.2

The magic number is 39.

					Total
	A 2	B 7	C 18	D 12	39
	E 8	F 5	G 11	H 15	39
	I 13	J 17	K 6	L 3	39
	M 16	N 10	O 4	P 9	39
Total	39	39	39	39	

UNIT II - FOOD PROCESSING Name ________________

Lesson 1: Procedures Used in Processing Food Date ________________

EVALUATION

1. Name three reasons for food processing.

Match the definition in Column A with the correct term in Column B.

		Column A		Column B
____	2.	Removal of chaff, foreign material, soil	a.	Extrusion
____	3.	Separate the hulls, germ, bran, and endosperm	b.	Precipitating/centrifuging
____	4.	Converting vegetable oil into shortening	c.	Texturization
____	5.	Process that keeps oils and water from separating	d.	Emulsifying
____	6.	Microorganisms break starch into sugars	e.	Homogenizing
____	7.	Removal of moisture	f.	Hydrogenation
____	8.	Enriching food with needed ingredients	g.	Combination
____	9.	Separate a solid from a solution	h.	Fractionation
			i.	Grinding
			j.	Milling
			k.	Fermentation
			l.	Dehydration

Lesson 1: Procedures Used in Processing Food Name ________________

Dehydration and Rehydration

Objective: Observe the effects of dehydration of food. Students will be able to calculate the moisture content of fresh food.

Activity Length:	Part A:	1.5 days
	Part B:	1 day

Materials and Equipment:

sharp knife
scale
labels
fruit or vegetable (examples: apple, apricot, banana, bean, broccoli, cabbage, carrot, peach, pear, nectarine, orange, pumpkin, radish, and tomato)
dehydrator or standard oven
Fruit Fresh® or .1 percent solution sodium bisulfite

PART A: Dehydrate

Procedure:

1. Select food from those provided by your instructor.

2. Wash, peel, wash again, and remove the seeds from your fruit/vegetable.

3. Remove any surface moisture.

4. Cut into very thin slices.

5. Weigh cut produce. Divide produce into 2 equal portions. Record data in the table.

6. With ½ the fruit, apply Fruit Fresh® or sodium bisulfite. Follow label instructions.

7. Label produce with type of produce, your name, and with or without Fruit Fresh®. Dehydrate food. NOTE: Check with your instructor for proper use of the dehydrator or the standard oven, which is set on 200°F.

8. Remove produce from dehydrator.

9. Weigh and record your data in Table 1.1.

10. Calculate percentage of moisture in original sample.

$$\frac{\text{original weight - dried weight}}{\text{original weight}} \times 100 = \text{percent moisture}$$

Table 1.1

Type of Produce	Weight of Original Sample	Dried Weight	Volume H_2O Lost	% H_2O removed from Original	Color after dehydrating

Key Questions:

1. What are the benefits of dehydrating food?

2. How was the food's texture, flavor, and general appearance affected by dehydrating?

3. How do the fruits with Fruit Fresh® compare to the fruits without Fruit Fresh®?

4. Describe reasons why all foods are not dehydrated.

Fill in information on Table 1.1 about three different foods that were dehydrated by classmates. Make sure you get some information on fruit dried with and without Fruit Fresh®. Compare the dehydrated foods to the original foods.

5. Is there any difference in the amount of water in the original foods? Why?

PART B: Rehydrate

Name ________________

Procedure:

1. Place dehydrated food in a water bath overnight under refrigeration.
2. Weigh rehydrated food.
3. Calculate the volume of moisture that was regained. Rehydrated wt minus dried wt. equals volume regained.

Table 1.2

Weight of Original Sample	Dried Weight	Rehydrated Weight	Volume Gained

Key Question:

1. Can rehydrated fruit/vegetables completely regain their original water content? Why or why not?

Adapted from: Frick, Marty. *Food Science, Safety and Nutrition.* The National Council for Agricultural Education, 1993 and Mehas, Kay; Sharon Rodgers. *Food Science and You.* 1st ed. Mission Hills, CA: Glencoe Publishing, 1989.

UNIT II - FOOD PROCESSING AS 1.2

Lesson 1: Procedures Used in Processing Food Name ________________

Food Processing-Magic Square

Directions: Find the description on the following page which best fits each term. Write the number of the correct description in the space in each lettered square. If all your answers are correct, the total of the numbers, or the "Magic Number," will be the same in each row and column. Write the Magic Number in the space provided.

Terms

A. Anaerobic
B. Aerobic
C. Aseptic canning
D. Blanching
E. Commercially sterile
F. Controlled atmosphere
G. Cool storage
H. Food dehydration
I. Fortification
J. Frozen storage
K. Hypobaric storage
L. Irradiation
M. Pasteurization
N. Pathogenic
O. Precipitate
P. Shelf life

				Total
A	B	C	D	___
E	F	G	H	___
I	J	K	L	___
M	N	O	P	___
Total ___	___	___	___	

Descriptions:

1. This is the protein, carbohydrates, fat, minerals, and vitamins that are dissolved in milk.

2. Without oxygen

3. Processing with a limited number of kinds of radiant energy that together are referred to as ionizing radiations. This process is also called "cold sterilization" because it does not produce a significant amount of heat.

4. This means to cause a solid substance to separate from a solution.

5. Is used for apples and other fruits that respire, and then over ripen in cold storage. The system is based on reduced temperatures, depletion of oxygen and increased levels of carbon dioxide.

6. Refrigerated storage area maintained under reduced pressure and high humidity.

7. In the presence of oxygen

8. Means the degree of sterilization at which all pathogenic and toxin-forming organism have been destroyed, as well as all other types of organisms, which if present, could grow in the product and produce spoilage under normal handling and storage conditions.

9. The time a food product can safely be stored before deteriorating.

10. Disease carrying microorganisms

11. Refers to storage at temperatures above freezing, from 16°C down to -2°C. Commercial and household refrigerators are usually run at 4.5° to 7°C.

12. This is a kind of pasteurization process used to inactivate natural food enzymes in fruits and vegetables. It is typically used when these products are to be stored frozen (freezing will not completely stop enzyme activity).

13. Addition of a nutrient to foods such as adding vitamin D to milk

14. Addition of water to dehydrated foods

15. This refers to the nearly complete removal of water from foods under controlled conditions.

16. This involves a comparative low order of heat treatment (usually temperature is below the boiling point of water). Pasteurization is used to destroy pathogenic organisms associated with foods like milk. It is also used to extend product shelf life for products such as beer, wine, and fruit juices.

17. This requires temperatures of -18°C or below.

18. This refers to a method in which food is sterilized or commercially sterilized outside of the can and then aseptically placed in previously sterilized containers that are subsequently sealed in an aseptic environment.

Credit: Frick, Marty. *Food Science, Safety and Nutrition.* The National Council for Agricultural Education, 1993.

UNIT II - FOOD PROCESSING

Lesson 2: Food Product Development

Objective: The student will be able to describe the complexity of the development of food products.

Study Questions

1. **How are new food products developed and introduced into the marketplace?**
2. **How was margarine formulated?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.
2. Activity Sheet
    - a) AS 2.1: Soy Milk

UNIT II - FOOD PROCESSING

Lesson 2: Food Product Development

TEACHING PROCEDURES

A. Review

Review why food is processed and relate that processing procedures are determined by consumer demand. What if a consumer survey demands a product that is not yet available? What are the steps in product development?

B. Motivation

The students, collectively, make up a taste panel. Each student receives four chocolate chip cookies labelled A,B,C, and D: Cookie A has 2 times the salt, cookie B has 50 percent of the flour, cookie C is made like the recipe, and cookie D has 50 percent of the sugar called for in the recipe. Students evaluate each sample based on its appearance, flavor, aroma, and texture. Students should write down their comments and report outcomes. Discuss what students liked or didn't like about the cookies.

Also works to compare three brands of saltine crackers or vanilla wafers. Tang®, Koolaid®, and orange juice is also an interesting comparison.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss how new food products are developed. Research in food science has been increasing as consumers become more mobile. Early research centered on practical problems in food preparation encountered in the home. Modern research is focusing on commercially important food products. While all product development begins with an idea, the complex series of steps that follow occur in no particular order. Have students complete AS 2.1.

   How are new food products developed and introduced into the marketplace?

   a) Idea - Food scientists (product developers) come up with ideas that may be generated by consumer complaints or suggestions, new regulations, new findings about nutrition, etc.
   b) Bench-top development - production of prototypes
   c) Objective testing - shelf-life and safety testing
   d) Sensory evaluation - do consumers like the taste, color, etc.
   e) Basic and applied research - to solve problems
   f) Pilot plant production - evaluates production process
   g) Engineering services - modify processing facilities
   h) Marketing surveys - to determine if product meets the desires of consumers
   i) Economic analysis - to determine costs of the product
   j) Test marketing - to determine if consumers will buy product
   k) National roll-outs - company commits to sell product
   l) Advertising campaigns - to advertise the new product

m) Brand maintenance - monitor the performance of the product

2. Discuss how margarine differs from butter.

How was margarine formulated?

a) The need for a new product was created by the shortage of butter during World War I.
b) The product developer's goal was to simulate butter using ingredients that were readily available.
    1) The emulsifier is obtained from soybeans.
    2) Hydrogenation is used to add hydrogen atoms to the fatty acids in soybeans.
    3) Hydrogenated oil, water, and lecithin are blended together to get the desired emulsion.
    4) Colors, flavors, and vitamins were added to make margarine a reasonable substitute for butter.

F. Other activities

1. Butter churning lab. Place appropriate quantity of cream in butter churn and let students churn until butter is complete, then lightly salt and form into desired shape. Rinse off and serve.

G. Conclusion

Food products are the product of lengthy efforts and only a few reach the product stage. All products begin as an idea that could be beneficial in terms of convenience, nutrition or economic reasons. The research and development process is a detailed process that precedes new product launch. Various foods eaten today are formulated foods resulting from food product development efforts.

H. Competency

Describe the complexity of the development of food products.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. a
2. b
3. d
4. a
5. c
6. b

J. Answers to Activity Sheet

AS 2.1

1. for lactose intolerant diets; value added product of soybeans, low fat product, etc.
2. instructor's discretion
3. instructor's discretion
4. instructor's discretion

UNIT II - FOOD PROCESSING Name ______________________________

Lesson 2: Food Product Development Date ______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. How are engineering services used in new product development?

   a. To modify processing facilities
   b. To evaluate production process
   c. To determine if consumers will buy the product
   d. To monitor the performance of the product

2. How is pilot plant production used in new product development?

   a. To modify processing facilities
   b. To evaluate production process
   c. To determine if consumers will buy the product
   d. To monitor the performance of the product

3. Which technique is used to determine if consumers like the taste, color, etc., of the product being developed?

   a. Advertising campaigns
   b. Economic analysis
   c. National roll-outs
   d. Sensory evaluation

4. Which phase of new product development uses the production of prototypes?

   a. Bench-top development
   b. Economic analysis
   c. Marketing surveys
   d. Test marketing

5. Why was margarine formulated?

   a. Consumers were tired of eating butter at every meal.
   b. Dairy cattle were needed to pull two-wheel carts.
   c. Butter wasn't available because it was being fed to the soldiers.
   d. Butter doesn't keep so a substitute needed to be developed.

6. What was the product developer's goal when formulating margarine?

   a. To eliminate butter from the market place
   b. To simulate butter using ingredients that were readily available
   c. To make a butter substitute at any cost
   d. To replace butter as the spread for breads

Lesson 2: Food Product Development

Name ________________

Soy Milk

Objective: Students will process soybeans to produce soy milk and design a food label for soy milk.

Activity Length: 2 periods

Background Information:

Commercial soy milk is often fortified with vitamins and minerals to approximate the composition of cow's milk. Soy milk may be used in place of cow's milk in most recipes. Due to the flavor difference between soy and cow's milk, you may prefer to use half soy milk and half cow's milk.

Soy milk is available commercially in dry, concentrated, and ready-to-use forms. Instructions for preparing, serving, and storing are on the package. Soy milk may also be prepared at home.

Materials and Equipment:

1 lb. (2½ c.) dry soybeans
Water
Blender
Cheesecloth
Cooking pot
2 T. Sugar
1 t. Salt

Procedure:

1. To prepare about 2 quarts of soy milk, use 1 pound (2 1/2 cups) dry soybeans. Sort and wash beans thoroughly.

2. Using 2 quarts of water, soak beans overnight or use the 2-minute-boil method.

3. Drain soaked beans, remove skins, and discard the soaking water. You only need to remove the skins from the beans if you wish to use the bean mash or pulp after the milk is made.

4. Using 3 quarts of water, grind the soaked beans in a blender. Place part of the beans and enough water to cover the beans in blender container; grind until very fine (about 2 minutes). Repeat until all beans have been ground and the 3 quarts of water have been used.

5. Strain ground beans through two layers of cheesecloth into a large kettle. Squeeze as much liquid from the mash as possible.

6. Boil the soy milk for 30 minutes, stirring occasionally to prevent scorching. It is necessary to cook the milk thoroughly to destroy a substance which interferes with trypsin, one of the digestive enzymes.

7. While the milk is still warm, add 2 tablespoons sugar and 1 teaspoon salt. Stir until dissolved.

8. Cover milk tightly and store in the refrigerator.

9. Strain milk before using because a skin often forms on the surface.

10. Following refrigeration, compare soy milk's flavor and texture to cow's milk and answer the following questions then design a label for a jar of soy milk to enhance its share of the market.

Key Questions:

1. Why is soy milk produced?

2. What are soy milk's positive attributes?

3. How does its flavor and texture compare to cow's milk?

4. What size market share do you expect soy milk to gain in the future?

Credit: Missouri Soybean Association and the Missouri Soybean Merchandising Council, P.O. Box 104778, Jefferson City, MO 65110-4778.

UNIT II - FOOD PROCESSING

Lesson 3: Milk Processing

Objective: The student will be able to identify products produced from different grades of raw milk.

Study Questions

1. **What are the quality grades of milk?**
2. **What major products can be produced from raw milk?**
3. **What by-products result from milk processing?**
4. **What factors affect milk taste and composition?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.
2. Activity Sheets
    a) AS 3.1: Determining Thresholds for Off-flavors in Milk Using a Triangle Sensory Test (Instructor)
    b) AS 3.1: Determining Thresholds for Off-flavors in Milk Using a Triangle Sensory Test (Student)

UNIT II - FOOD PROCESSING

Lesson 3: Milk Processing

TEACHING PROCEDURES

A. Review

In Lesson 2, the difference between margarine and butter was discussed. This lesson will discuss how raw milk is processed into milk products.

B. Motivation

1. Show video,"The Dairy Plant," available from Creative Educational Video (CEV).

2. Have students taste test different types of milk: whole milk, 2 percent milk, 1 percent milk, cultured buttermilk, evaporated milk, sweetened condensed milk, milk substitute, and dried/reconstituted milk.

C. Assignment

D. Supervised Study

E. Discussion

1. Discuss the quality grades of milk.

What are the quality grades of milk?

a) Grade A raw milk
b) Manufacturing grade (can be referred to as Grade B or Grade C)
c) Reject

2. Discuss what major products are produced from raw milk.

What major products can be produced from raw milk?

a) Fluid milk (must be made from grade A milk only)
    1) Whole milk - greater than or equal to 3.25 percent fat (raw milk is usually 3.6-3.7 percent fat)
    2) Low-fat milk
        (a) 2 percent fat
        (b) 1.5 percent fat
        (c) 1 percent fat
        (d) 1/2 percent fat
    3) Non-fat milk - less than 0.5 percent fat (skim milk)
    4) Chocolate milk - a combination of chocolate flavoring with whole, low-fat, or skim milk
b) Fermented milk (must be made from grade A milk)
    1) Cultured buttermilk - skim milk that has been pasteurized, inoculated with lactic acid-producing bacteria, and held at 72°F.
    2) Yogurt
    3) Acidophilus milk

- c) Creams (must be made from grade A milk)
    - 1) Half-and-half - about 11 percent fat
    - 2) Cream - 18 percent fat
    - 3) Whipping cream - 30 percent fat
    - 4) Coffee cream - 18 percent fat
    - 5) Heavy whipping cream - 36 percent fat
    - 6) Sour cream - cultured, 18 percent fat
- d) Butter
- e) Canned milk
    - 1) Evaporated milk - 60 percent water removed
    - 2) Sweetened condensed milk
- f) Dried milk - usually nonfat dried milk
- g) Cheeses
- h) Ice cream

3. Discuss what by-products result from milk processing.

What by-products result from milk processing?

- a) Buttermilk - from butter making; usually is dried for sale to bakers
- b) Whey - liquid remaining after the curd develops and is separated and removed; it can be dried, demineralized, and concentrated

4. Discuss what factors affect milk flavor and/or composition.

What factors affect milk taste and composition?

- a) Antibiotics - may inhibit growth of bacterial cultures
- b) Added water
- c) Sediment
- d) Pesticide contamination - are not known to change flavor; only minutely change composition
- e) Radionuclides - are not known to change flavor; only minutely change composition
- f) High bacterial counts
- g) Fat content
- h) Age of milk
- i) Species, breed, individuality of animal, age, stage of lactation, season of year, feed, time of milking, period of time between milkings, physiological condition of cow (calm or excited)
- j) Facilities - unlikely to affect flavor or composition in today's operations
- k) Temperature of milk and rate of cooling
- l) Offensive feeds that could be in cow's feed

F. Other activities

1. Use the IML Dairy Foods contest slide set to help students in evaluating off flavors in milk.

2. Have student discuss their opinions on the different milks tasted. The instructor could cover the labels and relabel with "A," "B," "C," etc. to see if students are able to identify the different products.

G. Conclusion

Milk is a balanced food that plays a vital role in a healthy diet. Milk grades reflect differences in requirements for facilities and operations at the farm, during assembly and in processing as well as in permitted bacteria counts. Milk is very versatile and can be made into many different products.

H. Competency

Identify products produced from different grades of raw milk.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. Grade A raw milk, manufacturer's grade (Grade B or C)
2. Grade A
3. Whole - 3.25 percent or greater milk fat
   Low-fat - 2 percent, 1.5 percent, 1 percent, or 0.5 percent milk fat
   Chocolate - chocolate flavoring has been added to either whole or low-fat milk

4. Cultured buttermilk is skim milk that has been pasteurized, and then inoculated with lactic acid-producing bacteria and held at 72°F.

5. Whipping cream
6. b
7. a
8. d

UNIT II - FOOD PROCESSING Name ____________________

Lesson 3: Milk Processing Date ____________________

EVALUATION

Complete the following short answer questions.

1. Name the two quality grades of milk.

2. Which quality grade is used for fluid milk processing?

3. How much milk fat is contained in each of the following types of milk: whole, low-fat, and chocolate milk?

4. How is cultured buttermilk produced?

5. Which has a higher fat content, half-and-half or whipping cream?

Circle the letter that corresponds to the best answer.

6. From what product is whey a by-product?
   a. Cultured buttermilk
   b. Cheese
   c. Ice cream
   d. Butter

7. What has the greatest impact on milk composition?
   a. Breed of cow
   b. Age of cow
   c. Facilities
   d. Time of milking

8. A cow with mastitis would be discovered with which test?
   a. Pesticide test
   b. Sediment test
   c. Mycotoxin test
   d. Somatic cell count

Determining Thresholds for Off-flavors in Milk Using a Triangle Sensory Test

Objective: Students will determine thresholds for off-flavors in milk using a Triangle sensory test.

Materials and Equipment:

Note: These are needed to make the samples for 10 students; not one set for each student.

1/2 pt. of cultured buttermilk
1/2 gal. pasteurized, homogenized milk
1/3 cup silage
1/4 tsp. table salt
Garlic salt or fresh onion
5 flasks or containers, 500 ml or 1 pint, with closures or covers
1-one liter Erlenmeyer flask fitted with a one-hole rubber stopper into which a glass or plastic tube is inserted to the bottom of the stopper. Attach a 15-inch (40 cm) hose to the tube for delivery of vapors from the silage sample to milk
Tripod or ring stand and wire gauze and Bunsen burner
Fluorescent lamp without cover or shield
4 oz. cups - 3 for each test per number of students

Procedure:

A. Preparation:

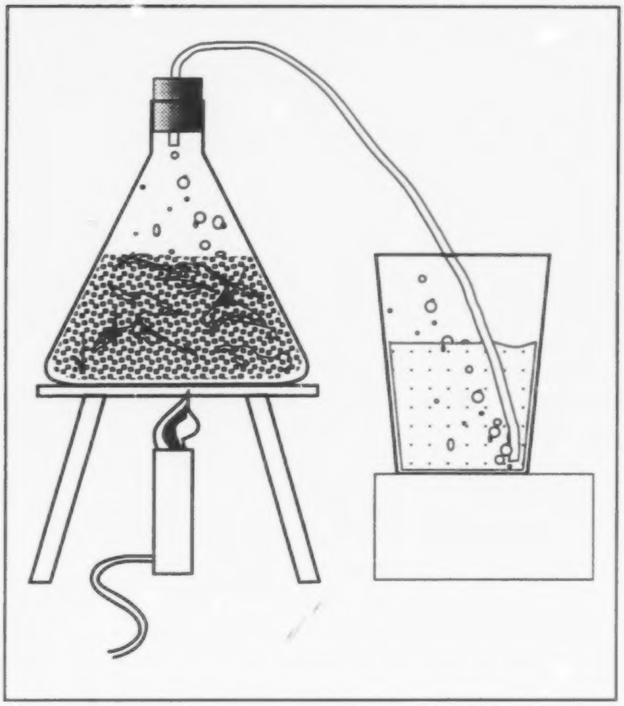
1. The formulas that follow are designed for 10 individuals and will provide more than 20 ml per person for tasting. If more than 10 students will be testing the samples, increase the amount of flavors in proportion to the number of students.

2. Flavors to be prepared are feed, high acid (sour), garlic/onion, oxidized and salty. These are chosen because they represent important flavors of milk and some other foods. Furthermore, they can be tasted within a 50-min. period. It is suggested that the flavorings be prepared before class. Prepare samples at the beginning of class. For Phase I, use the strengths included under each test preparation.

   a. Test A - Feed: this defect is prepared by boiling a suspension of silage in water and collecting in milk the steam that contains volatiles from the silage. Add about 1/3 cup of silage to about 125 ml (1/2 cup) of water in the 1-liter Erlenmeyer flask. Insert into the top of the flask the stopper with the tube and hose. Place on stand and heat with the Bunsen burner (see Figure 3.1). Collect steam volatiles in about 200 ml of milk in a 400 ml beaker or flask by inserting the hose into the milk while boiling the silage-water suspension. Collect volatiles for about 5 min. after boiling has started.

   To stop the operation remove the hose from the milk and turn off the burner at the same time. Do not leave the hose in the milk after the burner is off. To do so allows vacuum created in the flask, as it cools, to suck milk into the silage. Do not allow the hose to kink or to restrict air flow through the tube after the burner is off. A vacuum

Figure 3.1 - Bunsen Burner Setup



created in the flask can cause a defective flask to burst or can pull a slightly too small stopper into the flask.

Use this milk to flavor the sample to be tasted. The amount to use varies with the silage used. Start with 10 ml of silage-flavored milk in 200 ml of fresh milk. Adjust amount added after comparing the flavor and odor to that of an untreated portion of fresh milk.

b. Test B - High acid: Add 15 ml (1 tablespoon) of cultured buttermilk to 220 ml of fresh milk and stir. Compare flavor to that of fresh milk control and adjust amount added to increase or decrease flavor and odor intensity.

c. Test C - Garlic or onion: Add a sprinkle of garlic salt (about 50 grains estimated) to 220 ml of milk. Mix well, let set 5 min., mix again. Compare flavor and odor to that of untreated control. If flavor is too high, use this sample to treat fresh milk adding 10-20 ml each time until the flavor is slight, definite and pronounced.

Alternatively, press juice from a section of the interior of an onion and add single drops to 220 ml of milk until the flavor is slight, definite and/or pronounced.

d. Test D - Oxidized: This flavor is emphasized because of its high incidence in milk packaged in "see-through" plastic jugs that are displayed for sale under fluorescent light.

Place 220 ml of milk in a glass container and expose the sample for 20-30 min. to direct rays from a fluorescent lamp. Sample and lamp should be within 6 inches of each other. The reaction rate can be accelerated by addition of a washed copper penny or by a drop of 1% copper sulfate.

A similar flavor is produced in milk exposed to direct high intensity sunlight for 15 to 30 min.

Milks vary in their susceptibility to oxidation, so prolonged exposure to light or sample dilution may be necessary. Compare flavor of treated and untreated samples to make sure the off flavor is definitely discernible.

e. Test E - Salty: Place 0.1 g of salt in 9.9 ml of fresh milk. Use this 1:100 solution to add 1 ml to 100 ml of milk making the equivalent of 100 parts per million or 100 mg/liter. Compare the flavor to that of fresh milk. Adjust the flavor intensity upward by adding 1 ml at a time until the saltiness is slight, definite and/or pronounced.

B. Testing: Thresholds for flavor detection vary among individuals. It is essential to know that the flavor intensity is high enough for all individuals to recognize it. Of course, no one wants to taste a sample that is very pronounced in its off flavor, so do not over-flavor.

A good way to determine whether the flavor intensity is high enough is to do a triangle test. Here is the procedure.

Number small cups, such as 4 oz styrofoam, with 3-digit numbers. Numbers have been selected and included in the student form of AS 3.1. If different numbers are selected, a different record needs to be made for students.

For each off flavor to be tested you need 3 cups per person. For example, to test the salty sample with a group of 10 prepare 30 cups. Pour about 20 ml of the treated sample into about 15 cups and 20 ml of untreated sample into the remainder. NOW the critical part is to make a chart showing how each of these samples is distributed to the students. Each person gets 2 cups of one set and 1 cup of the other set. Half the students will have two treated samples and the other half will have two untreated samples. They are served in random order. You must record the number and content of each cup for each student.

Present these "blindfold" samples to the group asking each person to indicate which two samples are alike. A table for record keeping has been provided in the student copy.

Indicate to students what they should do with samples after tasting. Also, you will need to let students know if they selected the correct samples for each test.

For Phase II, dilute or double the strength of the flavoring based on student results from Phase I. If all students selected the correct samples, dilute the strength of the flavoring. If less than seven students selected the correct samples, double the strength of the flavoring.

Credit: Robert T. Marshall, Professor Food Science and Nutrition, University of Missouri.

Lesson 3: Milk Processing

Name ________________

Determining Thresholds for Off-flavors in Milk Using a Triangle Sensory Test

Objective: Students will determine thresholds for off-flavors in milk using a triangle sensory test.

Activity Length: 1 class period

Background Information: In phase I, you will be testing five (5) different off-flavors. In each test, you will be tasting three different samples. All samples will be coded with numbers (420, 062, etc.) by your instructor. Depending on your instructor, you may be asked to complete Phase II which calls for tasting five additional sets.

Materials and Equipment:

Milk samples - provided by instructor
Container to discard tasted milk samples

Procedure:

1. Obtain the first samples (Test A) from your instructor.

2. Taste the milk in each cup in order presented, left to right. Do not swallow the milk. Put it in waste container. This is standard for a Triangle Sensory Test.

3. Answer the question, which two samples are the same by marking an "X" by the appropriate numbers in the table.

PHASE I	**Sample on Left**	**Sample in Middle**	**Sample on Right**
Test A	420	062	153
Test B	091	579	221
Test C	656	892	356
Test D	129	442	056
Test E	718	389	978
PHASE II	**Sample on Left**	**Sample in Middle**	**Sample on Right**
Test F	329	011	921
Test G	756	423	291
Test H	152	625	867
Test I	024	372	735
Test J	922	543	231

4. Return samples to instructor or dispose of samples as directed.

5. Give your responses to your instructor.

Note: Your instructor will tabulate results.

6. Repeat steps 1-5 for Tests B, C, D, and E.

7. If directed by your instructor, complete Phase II by repeating steps 1 through 5 for Tests F, G, H, I, and J.

Key Questions:

1. In Phase I, did you select the correct samples in each test? Explain why you think you were able or not able to select the correct samples in each test.

2. How did you do compared to other students in the class?

3. If not all students selected the correct samples, why do you think there were differences?

4. If Phase II was completed, how did you do in selecting the correct samples in each test? Explain why you think you were able or not able to select the correct samples in each test.

5. In Phase II, how did you do compared to other students in the class?

6. If not all students selected the correct samples in Phase II, why do you think there were differences?

Credit: Robert T. Marshall, Professor of Food Science and Nutrition, University of Missouri-Columbia.

UNIT II - FOOD PROCESSING

Lesson 4: Processing Dairy Products

Objective: The student will be able to summarize how dairy products are processed and packaged.

Study Questions

1. **What techniques are used to process raw milk?**
2. **Why is raw milk pasteurized and homogenized?**
3. **How are major dairy products processed?**
4. **Why should milk and dairy products be packaged?**
5. **How is the dairy processing industry organized?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.
2. Activity Sheets

    a) AS 4.1: Pasteurization in a Double Boiler (Instructor)
    b) AS 4.1: Pasteurization in a Double Boiler (Student)
    c) AS 4.2: Making Plain Yogurt (Instructor)
    d) AS 4.2: Making Plain Yogurt (Student)

UNIT II - FOOD PROCESSING

Lesson 4: Processing Dairy Products

TEACHING PROCEDURES

A. Review

Lesson 3 examined the products of raw milk, the grades of raw milk, and the factors that affect milk taste and composition. Review the grades of raw milk and explain that Grades A and B milk undergo the processes discussed in this lesson.

B. Motivation

Have students work in pairs to process ice cream. Each pair will need:

½ c. milk
½ c. whipping cream
¼ c. sugar
Fruit and nuts (optional)
1 pt freezer bag
1 ½-gal. freezer bag
3 c. ice
½ c. salt

Have students measure the milk, whipping cream, sugar, and vanilla and place in pint freezer bag. Fruit and nuts may be added. Seal bag tightly while keeping as much air as possible in bag. Place sealed bag inside ½-gallon bag. Add ice and salt. Close tightly. Take turns shaking the bag until ice cream is set, about 10-15 minutes. Discuss why salt was added to the ice.

C. Assignment

D. Supervised Study

E. Discussion

1. Discuss what techniques are used to process raw milk. Between the time the milk leaves the cow and arrives at the grocer, nine processes take place.

   What techniques are used to process raw milk?

   a) Quality control tests
   b) Separation
   c) Standardization
   d) Clarification
   e) Pasteurization
   f) Homogenization
   g) Fortification
   h) Cooling
   i) Packaging

2. Discuss why raw milk is pasteurized and homogenized. Milk is pasteurized to prevent disease and homogenized for improved taste and appearance. Have students complete AS 4.1.

Why is raw milk pasteurized and homogenized?

a) Pasteurization is necessary to rid milk of any disease-producing microorganism and to reduce total bacterial numbers for improved shelf life. Also, pasteurization destroys lipase and other natural enzymes.
   1) Batch method
   2) HTST - high temperature short-time method

b) Homogenization subdivides fat globules and clumps to a small enough size to prevent their rising to the top and forming a cream layer. Homogenized milk has a richer taste and has a whiter appearance than unhomoginized milk.

3. Discuss how major dairy products are processed. Have students work in groups to complete AS 4.2.

How are major dairy products processed?

a) Whole milk - milk fat level standardized to at least 3.25 percent, pasteurized, homogenized, fortified with Vitamin D, and packaged
b) Low-fat milk - milk fat level standardized to ½ percent, 1 percent, 1.5 percent or 2 percent, pasteurized, homogenized, fortified with vitamins A and D, and packaged
c) Non-fat milk - milk fat level lowered below 0.5 percent, pasteurized, homogenized, fortified with vitamins A and D, and packaged
d) Chocolate milk - either whole, low fat, or non-fat milk is mixed with either chocolate syrup or cocoa powder and sugar
e) Cultured buttermilk - skim, low fat or whole milk heated to 185°F for 30 minutes, inoculated with lactic acid-producing bacteria and held at 72°F until acidity reaches about 0.85 percent or pH reaches about 4.5
f) Yogurt - fermented whole or skim milk by *Streptococcus thermophilus*, and *Lactobacillus bulgaricus*; pH is lowered to point where casein clabbers or coagulates
g) Acidophilus milk - fermented whole milk that has *Lactobacillus acidophilus* bacteria added to digest lactose
h) Cream - separated centrifugally from fluid milk, then processed into various fat-content creams
i) Sour cream - following pasteurization, cream is cultured with lactic acid-forming bacteria
j) Butter - cream is churned to break the oil-in-water emulsion and to form a water-in-oil emulsion; washed with cold water and worked to reduce water content to 15 percent
k) Canned milk - 60 percent of water in the milk removed; carrageenan gum added to give a smooth texture; homogenized, canned, sterilized at 240°F for 15 minutes, sweetened condensed milk is canned milk with sugar added
l) Nonfat dried milk - dehydrated milk that can be stored for long periods
m) Ice cream - milk is heated to 110°F, sugar, emulsifier, stabilizer, and flavorings are added; it is pasteurized, homogenized, aged slightly, frozen to 22°F, and whipped with air; semi-solid ice cream is packaged then hardened to about -20°F
n) Natural cheese - pasteurized milk with the enzyme rennin added; the lactose in the milk is converted to lactic acid by bacterial cultures which reduce the pH from 6.7 to 4.6; at this point the soft curd develops which is then cut to release the whey; it is heated, pressed to 40 percent water, salted, shaped, ripened to alter texture, odor, and flavor; cottage cheese and cream cheese are not ripened
o) Processed cheese - different types of natural cheese are mixed and ground together and then melted to a uniform product with the aid of emulsifiers

4. Discuss why milk and dairy products should be packaged. Milk can be bought in glass, clear plastic, opaque plastic, cardboard, etc. How it can be packaged is not as important as why it should be packaged.

   Why should milk and dairy products be packaged?

   a) Increases shelf-life and freshness - decreases mold and bacterial contamination
   b) Fluid milk contains light sensitive riboflavin (Vitamin B_2), thiamine, Vitamin A and Vitamin C - Opaque packaging reduces the breakdown of these
   c) Dried milk must be packaged in a material impermeable to oxygen

5. Discuss how the dairy processing industry is organized. Cooperatives play an important role.

   How is the dairy processing industry organized?

   a) Individual producers belonging to cooperatives
   b) Cooperative processes wholesale milk, cheese, ice cream, etc.
   c) International Dairy Foods Association conducts research, educational, promotional, regulatory, legislative, and training activities.

F. Other activities

1. Complete Cottage Cheese Lab as instructed in the University of Missouri Extension Guide #G09550. It is included as Appendix B.

2. Invite a dairy cooperative representative to discuss the coop's role.

3. Teacher demonstration: Fill five test tubes of raw milk and 5 test tubes of pasteurized milk ¾ full and refrigerate at 45°F. Watch for changes, coagulation, gas bubbles, and digestion (clearing of fluid). Check pH with litmus paper for about two weeks.

4. Show the video from United Dairy Industry Association on milk commercials.

G. Conclusion

Before milk arrives at the grocery store, it is tested, standardized, clarified, pasteurized, homogenized, fortified, cooled, and packaged. Pasteurization is critical in maintaining milk quality and safety by killing spoilage and disease-producing microorganisms. Homogenization improves milk's texture and flavor. Proper packaging is needed to maintain freshness and increase shelf life.

H. Competency

Summarize how dairy products are processed and packaged.

Related Core Competencies and Key Skills:

9D-6: Identify the control, the dependent, and the independent variables in an experiment.
9E-5: Identify the basic and acidic ranges and the neutral point on the pH scale.

I. Answers to Evaluation

1. a
2. c
3. d

4. c
5. Homogenization provides a consistent texture and flavor. It prevents cream from rising.
6. Acidophilus milk is produced for lactose-intolerant people.
7. Instructor's discretion
8. Ice cream - 10 percent milk fat; sherbet - 1 to 2 percent milk fat
9. Packaging enhances freshness and shelf-life, is necessary for dried milk to hold nitrogen gas, and prevents riboflavin breakdown.

J. Answers to Activity Sheets

AS 4.1

1. most likely, tube A
2. most likely, tube B
3. most likely, tube G
4. whether spoilage was by acid-producing bacteria (pink)
5. to prevent cross contamination
6. 145°F is the critical temperature and it must be maintained for 30 minutes for pasteurization to take place (or 161°F for 15 seconds).

AS 4.2

1. Gelatin is a thickening agent.
2. D
3. E

Name ____________________

Lesson 4: Processing of Dairy Products

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Pasteurizing milk using the HTST method requires that milk is heated to ____ for ____.
    a. 161°F, 15 seconds
    b. 145°F, 30 minutes
    c. 130°F, 45 minutes
    d. 30°F, 145 seconds

2. Whole milk is a minimum of ____ milk fat.
    a. 1.0 percent
    b. 2.0 percent
    c. 3.25 percent
    d. 12.65 percent

3. Whole milk is fortified with ____ vitamin(s).
    a. C
    b. A & C
    c. A & D
    d. D

4. Low-fat milk and skim milk are fortified with ____ vitamin(s).
    a. C
    b. A & C
    c. A & D
    d. D

Complete the following short answer questions.

5. Why is milk homogenized?

6. Why is acidophilus milk produced?

7. Write an essay on the cheese-making process. Use each of the following terms appropriately: rennin, lactic acid, lactose, pH, cutting the curd, whey, salted, and shaped.

8. What is the difference between ice cream and sherbet?

9. Give two reasons why packaging dairy products is important.

Pasteurization in a Double Boiler

Prepare litmus solution to be used in AS 4.1, Pasteurization in a Double Boiler.

Reagent: litmus, available from Signa Chemical Company, St. Louis, MO., 800-325-3010 (catalog number L7382, about $1/gram)

Procedure:

1. Add 5 g. litmus to 50 ml distilled water. Heat in a boiling water bath for 30 minutes or until dissolved. Make more or less solution depending on the class size. You will need 0.5 ml for each test tube of milk used.
2. Cover and cool overnight.
3. Filter through filter-paper (Whatman No. 12. A coffee filter will work fine.)
4. This solution is stable for at least one year if kept in a cool, dark place.
5. The day before use, pipette 0.5 ml of litmus solution into each test tube to be used the next day. Place the test tubes in a boiling water bath for 30 minutes. Remove from heat and allow to cool overnight. (If you have access to an autoclave, you can sterilize the solution at 121°C [250°F, 15 psi] for 20 minutes.)

Additional notes about pasteurization in a double boiler:

Step 2: Cultured yogurt, cottage cheese or sour cream could be substituted for the buttermilk, although best results will be obtained using fresh buttermilk. Be certain that the ingredients statement includes the words 'active starter culture' or similar.

Step 3: Maintaining the temperature may require adjustment of the heat source. Be certain that water touches the bottom of the upper pan in the double boiler at all times.

Step 7: If two sets of samples can be obtained, store one set at 7°C (45°F) and another at 25°C (72°F). Compare results between the two temperatures.

Lesson 4: Processing Dairy Products

Name ____________________

Pasteurization in a Double Boiler

Objective: Students will determine the critical temperature needed to pasteurize milk.

Activity Length: 2 periods, 10 minutes for 10 periods thereafter

Materials and Equipment:

raw milk, or pasteurized milk with cultured buttermilk
double boiler
heat source
7 sterile pipets (5-10ml)
7 sterile test tubes containing litmus solution with screw caps
test tube rack
thermometers
ice bath
refrigerator
sterile stirring rod
sterile eye dropper
timer or watch

Procedure:

1. Place water in bottom pan of double boiler and bring to a boil.

2. Place raw milk or pasteurized milk containing 1 percent cultured buttermilk in top pan (minimum of 100 ml of milk).

3. Heat milk, stirring every 1-2 minutes with a stirring rod until the temperature reaches 63°C (145°F). Continue to stir and maintain 63°C (145°F).

4. Remove 5 ml of hot milk with a sterile pipet and place the milk into the test tubes containing the sterilized litmus solution. Screw on the cap, and mix the milk and litmus solution together well.

5. Immediately following the transfer of milk to the test tube, place the test tube in an ice/water bath and cool to about 7°C (45°F).

6. While maintaining 63°C (145°F) with the remaining milk in the double boiler, at 5-minute intervals remove 5 ml of milk and place it in sterile test tubes marked B, C, D, E, F, and G. Be sure to use a different, sterile pipet for each sample. Complete Step 5 after filling each test tube.

7. Store all tubes at 7°C (45°F) and observe daily for evidence of spoilage: coagulation, gas bubbles, solubilization (digestion of protein).

8. Record and analyze data for the effects of heating and time of heating before the milk begins to spoil.

9. Complete the chart describing the physical evidence of spoilage and color changes due to pH alterations.

TUBE

	A	B	C	D	E	F	G
DAY 1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Key Questions:

1. Which tube(s) showed signs of spoilage first?

2. Which tube(s) showed signs of spoilage second?

3. Did you have a tube that never showed signs of spoilage? If so, which one(s)?

4. What did the litmus solution tell you? (Some bacteria reduce--opposite of oxidize--litmus causing it to become colorless. If this happens, color will appear at the top of the tube where milk is exposed to O_2.)

5. Why did you use a different sterile pipet for each sample?

6. What can you conclude about the necessity of temperature and length of heating time for pasteurization to take place?

Adapted from: "Making Yogurt at Home," University Extension Guide #GH1183.

Making Plain Yogurt

Objective: The student will be able to identify the ingredients needed to produce yogurt and explain why each is needed.

Activity Length: 2 periods (4 hours incubation time)

Background Information:

With the exception of a commercial yogurt maker with an electrically heated base, most of the equipment needed to prepare yogurt can be found in any kitchen. Make sure you have all the necessary equipment **before** you begin preparing yogurt. This recipe makes 4 to 5 cups. Yogurt can be stored in the refrigerator for about 10 days. This recipe can be doubled or tripled with no loss of quality, but make sure you can use that amount in 10 days or less. Adjust pan and container size accordingly.

Materials and Equipment: (1 set per group of students)

Double boiler that holds at least 5 cups
Candy thermometer with a range of 100°F to 300°F
Container for yogurt that holds at least 5 cups (glass, crockery, food-grade plastic or stainless steel), or use individual custard cups or jelly jars--then the yogurt can be eaten directly from the container in which it was made.
Other useful equipment: large spoon, large bowl, and aluminum foil or plastic wrap to cover yogurt containers if they don't have lids
Incubator to maintain a constant temperature of 108°F to 112°F when incubating yogurt. (The most foolproof method for incubating yogurt is in a commercial yogurt-maker with an electrically heated base. If you don't want to purchase a yogurt-maker, experiment with the other methods of incubation described in *Table 1* until you find one that fits your needs.)

1 quart milk (whole, low-fat, skim or reconstituted nonfat dry milk) **A safety precaution: If you use home-produced milk, either from a cow or goat, it must be pasteurized before preparing yogurt or any other milk product.**
Nonfat dry milk powder - use ⅓ cup powder when using whole or low-fat milk, use ⅔ cup powder when using skim or reconstituted nonfat dry milk
¼ cup commercial, unflavored, cultured yogurt*
2 to 4 tablespoons sugar or honey (optional)
½ package (1 teaspoon) unflavored gelatin (for thick, firm yogurt only)

***Special hint:** To make yogurt in the classroom or at home, an active (living) yogurt culture is needed as a "starter." Commercial, unflavored cultured yogurt, from the supermarket is usually used. Yogurt starter cultures can also be purchased at health food stores, but are quite expensive compared to commercial cultured yogurt. Once you start making yogurt, save some of your homemade yogurt to "start" your next batch. For best results, however, purchase commercial cultured yogurt to replenish a homemade culture every four to five batches.

Procedure:

1. Thoroughly wash equipment for making yogurt and container(s) with hot, soapy water. Rinse everything thoroughly and air dry. A dishwasher can also be used.

2. Pour boiling water into the yogurt container(s) and leave until ready to use.

3. Prepare the incubator following manufacturer's instructions (*see Table 1*). Instruct students on how the incubator should be operated.

Table 1

Incubators

- **Method A:** Prewarm oven to 200°F and turn off. Use an oven thermometer to monitor temperature -- do not let it drop below 100°F. Turn oven on for short periods during incubation to maintain temperature of 108°F to 112°F.
- **Method B:** Line an ice chest (picnic cooler) with aluminum foil. Place four, one-quart jars filled with hot water (about 140°F) inside the ice chest with the yogurt container(s) and cover ice chest with a tight-fitting lid. Allow space between jars and container(s) of yogurt.
- **Method C:** Nestle several cardboard boxes inside each other, placing crushed newspapers between each box. Continue as directed in Method B for ice chest.
- **Method D:** A simple way to incubate a small amount of yogurt is to pour the mixture into a wide-mouth thermos and cover with a tight lid. When the yogurt is ready, loosen the thermos lid before storing in the refrigerator so the yogurt can cool rapidly.
- **Method E:** Set filled container(s) of yogurt on a towel-covered heating pad, set on medium heat, in a sheltered corner on a kitchen counter. Cover the jars with several towels.

For Thin Yogurt:

4. Place cold, pasteurized milk in top of a double boiler and stir in nonfat dry milk powder. Add sugar or honey if a sweeter, less tart yogurt, is desired.
5. Heat milk to 200°F, stirring gently, and hold for ten minutes. **Do not boil**.
6. Place top of double boiler in cold water to cool milk rapidly to 112°F to 115°F. Watch the temperature carefully as it falls rapidly once it reaches 125°F. Remove pan from cold water.
7. Remove one cup of the warm milk and blend it with the yogurt, starter culture. Add this to the rest of the warm milk. Temperature should now be 110°F to 112°F.
8. Pour water out of the yogurt container.
9. Pour the yogurt immediately into the clean hot container(s), cover and place in prepared incubator. Close incubator.
10. Incubate about 4 hours. Yogurt should be set. The longer the incubation time, the more tart or acidic the flavor.
11. Refrigerate immediately. Rapid cooling stops the development of acid. Yogurt will keep for about ten days if held at 40°F or lower (normal refrigerator temperature).

For Thick, Firm Yogurt: (Follow steps 1 through 3 above.)

4. Place cold, pasteurized milk in the top of the double boiler and stir in nonfat dry milk powder. Stir in sugar or honey if sweeter, less tart yogurt is desired. Sprinkle gelatin over the milk. Let stand for 5 minutes to soften gelatin.
5. Heat milk to 200°F and hold for 20 to 30 minutes, stirring gently to dissolve gelatin. Continue from Step 6 under *Thin Yogurt*.

Adapted from: *Making Yogurt at Home*, University of Missouri Extension Guide #GH1183.

AS 4.2
Student

Name ____________________

Making Plain Yogurt

Objective: The student will be able to identify the ingredients needed to produce yogurt and explain why each is needed.

Activity Length: 2 periods (4 hours incubation time)

Materials and Equipment:

Double boiler
Candy thermometer
Container for yogurt that holds at least 5 cups (glass, crockery, food-grade plastic or stainless steel), or use individual custard cups or jelly jars with lids if possible.
Large spoon
Large bowl
Aluminum foil or plastic wrap to cover yogurt containers (if they don't have lids).
Incubator
1 quart milk (whole, low-fat, skim or reconstituted nonfat dry milk)
Nonfat dry milk power - Use ⅓ cup powder when using whole or low-fat milk, use ⅔ cup powder when using skim or reconstituted nonfat dry milk.
¼ cup commercial, unflavored, cultured yogurt*
2 to 4 tablespoons sugar or honey (optional)
½ package (1 teaspoon) unflavored gelatin (for thick, firm yogurt only)

Procedure:

12. Thoroughly wash equipment for making yogurt and container(s) with **hot**, soapy water. Rinse everything thoroughly and air dry. A dishwasher can also be used.

13. Pour boiling water into the yogurt container(s) and leave until ready to use.

14. Prepare the incubator following your instructor's directions.

For Thin Yogurt:

15. Place cold, pasteurized milk in top of a double boiler and stir in nonfat dry milk powder. Add sugar or honey if a sweeter, less tart yogurt is desired.

16. Heat milk to 200°F, stirring gently, and hold for ten minutes. **Do not boil.**

17. Place top of double boiler in cold water to cool milk rapidly to 112°F to 115°F. Watch the temperature carefully as it falls rapidly once it reaches 125°F. Remove pan from cold water.

18. Remove one cup of the warm milk and blend it with the yogurt starter culture. Add this to the rest of the warm milk. Temperature should now be 110°F to 112°F.

19. Pour water out of the yogurt container.

20. Pour the yogurt immediately into the clean hot container(s), cover and place in prepared incubator. Close incubator.

21. Incubate about 4 hours. Yogurt should be set. The longer the incubation time, the more tart or acidic the flavor.

22. Refrigerate immediately. Rapid cooling stops the development of acid. Yogurt will keep for about ten days if held at 40°F or lower (normal refrigerator temperature).

For Thick, Firm Yogurt: (Follow steps 1 through 3 above.)

4. Place cold, pasteurized milk in the top of a double boiler and stir in nonfat dry milk powder. Stir in sugar or honey if sweeter, less tart yogurt is desired. *Sprinkle gelatin over the milk.* Let stand for 5 minutes to soften gelatin.

5. Heat milk to 200°F and hold for 20 to 30 minutes, stirring gently to dissolve gelatin. Continue from Step 6 under *Thin Yogurt.*

Key Questions:

1. For thick yogurt, why was gelatin added?

2. If yogurt developed an acid taste, which of the following could be true?

   a) temperature reached was too cool
   b) too short incubation period
   c) insufficient dry milk used
   d) too long incubation period

3. If yogurt does not become firm, what may be the cause?

   a) incubation temperature too high
   b) incubation temperature too low
   c) inactive culture
   d) soiled containers
   e) all of the above

Adapted from: *Making Yogurt at Home*, University of Missouri Extension Guide #GH1183.

UNIT II - FOOD PROCESSING

Lesson 5: Processing Egg Products

Objective: The student will be able to compare egg processing techniques to egg products.

Study Questions

1. **What are the major product forms of eggs?**
2. **What are the quality characteristics of eggs?**
3. **What factors influence egg quality?**
4. **How are eggs graded?**
5. **How are the different grades of eggs processed?**
6. **What are the sizes of eggs?**
7. **How is the egg processing industry organized?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.
2. Transparency Master
   - a) TM 5.1: Egg Structure
3. Activity Sheet
   - a) AS 5.1: Candling Eggs

Lesson 5: Processing Egg Products

TEACHING PROCEDURES

A. Review

Just as a cow's diet influences milk quality, Vitamin D, calcium, and xanthophyll influence egg quality. This lesson looks at egg processing from hen to grocer.

B. Motivation

1. Store an egg at room temperature for 1-3 days. Break onto a sheet of glass or a mirror. Compare to an egg stored at refrigeration temperatures. Notice yolk height, albumen height and thickness, albumen spread, yolk color, present of chalazae cords.

2. Make an egg white foam with eggs stored at two different temperatures. Add a pinch of cream of tarter to another egg before whipping. Put egg white foam in glass beaker and observe over a class period. How does temperature and pH affect foaming ability of eggs?

C. Assignment

D. Supervised Study

E. Discussion

1. Discuss what major products come from eggs.

What are the major product forms of eggs?

a) Shell eggs
b) Refrigerated liquid eggs
c) Frozen eggs
d) Dried eggs
e) Specialty products

2. Discuss the quality characteristics of eggs. Candling is passing eggs on rollers over high intensity lights to evaluate the interior. Haugh Unit System measures albumen height with a micrometer. Have students complete AS 5.1, Candling Eggs. TM 5.1 illustrates the physical structure of eggs.

What are the quality characteristics of eggs?

a) Exterior shell
    1) Cleanliness
    2) Soundness
    3) Texture
    4) Shape
b) Interior - candling process or Haugh Unit System used
    1) Air cell depth
    2) Albumen - clarity and firmness
    3) Yolk - outline distinctness, size, shape, blemishes

3. Discuss what factors influence egg quality. Brown eggs are laid by hens with red ear lobes (e.g., Rhode Island Red, New Hampshire, Plymouth Rock). White eggs are laid by hens with white ear lobes. Egg color does not affect egg quality, except for consumer's perception. (Brown eggs almost always command higher prices.)

   What factors influence egg quality?

   a) Facilities, equipment, and handling
   b) Hen's diet
      1) Minerals and vitamins influence shell strength
      2) Feeds with xanthophyll result in a medium, yellow yolk
   c) Breed of hen
   d) Hen's age - older hens lay eggs with thinner shells
   e) Hen's physiology - ruptured blood vessel may result in a blood spot
   f) Time after laying (age of egg)
   g) Genetics

4. Discuss how eggs are graded. The Egg Products Inspection Act of 1970 certifies USDA grading of all eggs carrying the official grade shield.

   How are eggs graded?

   Eggs are graded by a USDA grading service based on:
   a) AA - stands up tall; yolk is firm and there is a large proportion of thick albumen to thin albumen; shell is clean, sound, oval shaped, smooth texture
   b) A - medium in height, yolk is still firm while albumen begins to spread out, shell is clean, sound, oval shaped, smooth texture
   c) B - yolk is flat, more thin albumen than thick albumen; shell is clean, but possibly misshapened, rough or faulty textured

5. Discuss how the different grades of eggs are processed. All liquid and dried egg products must be pasteurized in the U.S.

   How are the different grades of eggs processed?

   a) Grade AA and A are regularly marketed as shell eggs. Surplus are processed.
   b) Grade B - processed, rarely sold as shell eggs

6. Discuss how eggs are sized. Size is not related to the quality grade.

   What are the sizes of eggs?

   a) Jumbo - 30 oz/dozen
   b) Extra Large - 27 oz/dozen
   c) Large - 24 oz/dozen
   d) Medium - 21 oz/dozen
   e) Small - 18 oz/dozen
   f) Peewee - 15 oz/dozen

7. Discuss how the egg processing industry is organized.

   How is the egg processing industry organized?

   a) Vertical integration - contracts between producers and large companies

F. Other activities

1. Hard boil 1 egg per 2 students. Have students dissect the egg and weigh its components. Refer students to Figure 5.1, Egg Composition in student reference.

2. Have students do "Easy Eggsperiments" from the American Egg Board.

G. Conclusion

Eggs are a valuable part of the human diet. Eggs are versatile in that they may be processed into a variety of forms. Egg quality is based on both interior and exterior characteristics of the egg. These characteristics are determined by a combination of the hen's genetics as well as her environment. This vertically integrated business grades eggs before they reach the grocer and processes them accordingly.

H. Competency

Compare egg processing techniques to egg products.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. b
2. a
3. a
4. b
5. a
6. A
7. B
8. AA
9. b
10. d
11. Three of the following: shell eggs, refrigerated liquid eggs, frozen eggs, dried eggs, or specialty products.
12. Instructor's discretion

J. Answers to Activity Sheet

AS 5.1

1. Instructor's discretion

2. 0_2 supply for embryo, should it develop

3. Normally the large end

UNIT II - FOOD PROCESSING Name ______________________

Lesson 5: Processing Egg Products Date ______________________

EVALUATION

Identify which characteristics are used to determine exterior quality or interior quality.

____1. Air cell depth a. Exterior quality characteristics

____2. Shape b. Interior quality characteristics

____3. Cleanliness

____4. Albumen clarity

____5. Shell texture

Match the characteristic with the type of grade.

____6. Medium yolk height, normal shell AA

____7. Flat yolk, thin albumen A

____8. Tall yolk, firm albumen B

9. What grade or grades of eggs are sold as shell eggs?

   a. Grade AA
   b. Grade AA and A
   c. Grade A
   d. Grade A and B

10. In the processing industry, producer's contract with large companies to produce eggs. What does the producer supply?

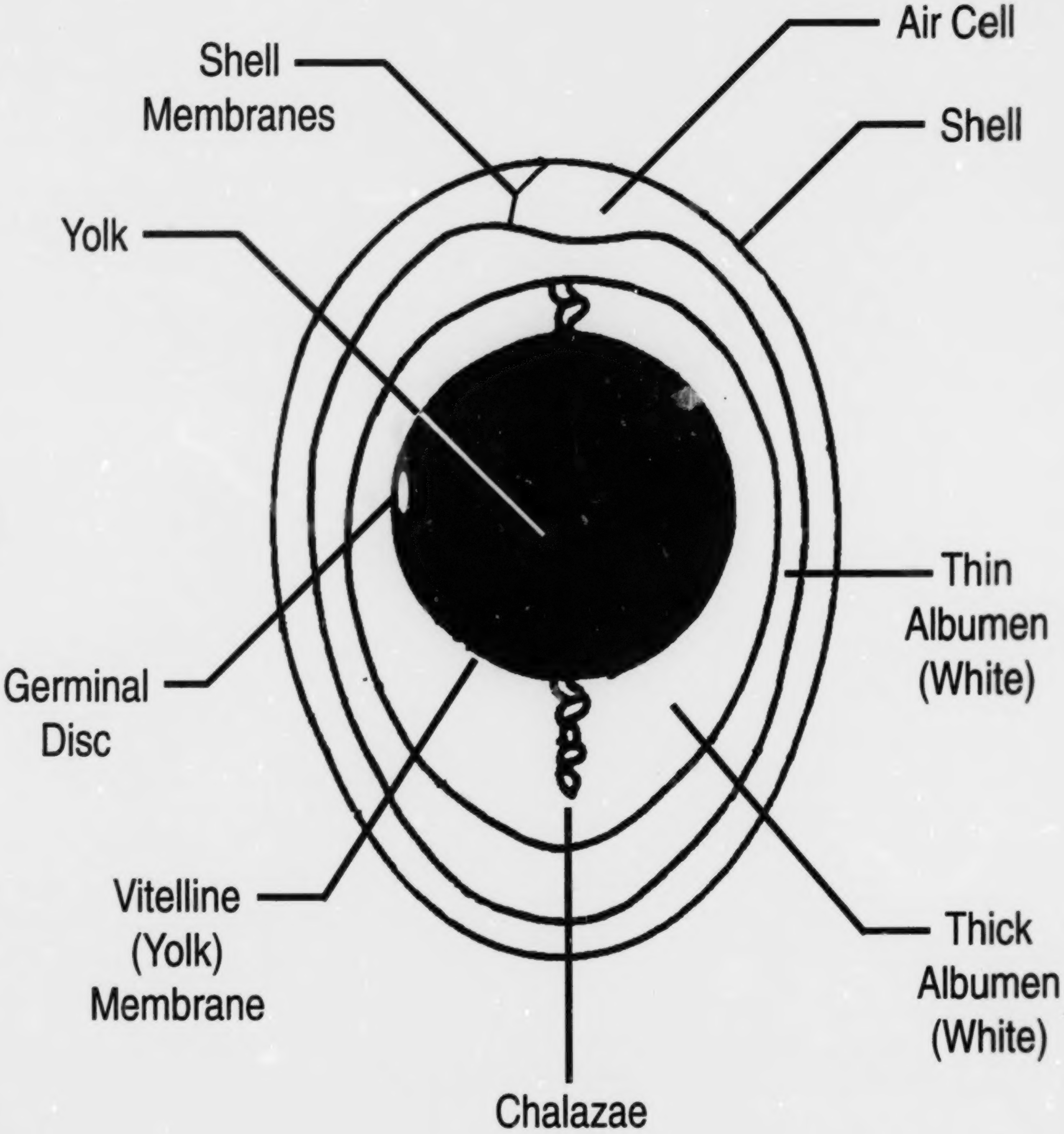
   a. Housing and feed
   b. Birds and feed
   c. Feed and labor
   d. Housing and labor

11. Name three major products made from eggs.

12. Discuss how a hen's diet can influence egg characteristics. Use xanthophyll, calcium, and vitamin D in your discussion.

Egg Structure

TM 5.1



Lesson 5: Processing Egg Products

Name ________________

Candling Eggs

Objective: Students will candle an egg to determine its interior quality, thus teaching them an understanding of egg grading.

Activity Length: 30 minutes

Materials and Equipment:

Aged eggs (store at room temperature 1-3 days, or buy 2 weeks in advance)
Fresh eggs
Candling lights (a strong flashlight works well)
Egg cartons
Break-out tray (paper plate will work), sheet of glass or a mirror
Ruler

Procedure:

NOTE: Complete the procedure with fresh eggs. Then use aged eggs.

1. Hold the egg up to the candling light in a slanting position.
2. Notice the air cell, the yolk, and the white. The air cell is nearly always in the large end of the egg. Therefore, put the large end next to the candling light.
3. Hold the egg between your thumb and first two fingers.
4. Then by turning your wrist quickly, you can cause the inside of the egg to whirl. This will tell you a great deal about the yolk and white. NOTE: When you are learning to candle, you will find it helpful to break (on break-out tray) and observe the eggs. Notice the viscosity of white, flattening of yolk, air sac size and location and presence of any blood spots.

Key Questions:

1. Draw a diagram of one aged egg and one fresh egg noting their air cell size and location.
2. What purpose does the air cell serve?
3. On which end of the egg is the air cell located for each egg candled? Large or small.

Lesson 6: Products and By-Products From Meat Animals

Objective: The student will be able to list the products and by-products from meat animals.

Study Questions

1. **What are the major meat animal species?**
2. **What are examples of fresh meat products?**
3. **What are examples of processed meat products?**
4. **What are examples of meat by-products?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.
2. Transparency Master
    a) TM 6.1: Anatomical Regions on Swine
3. Activity Sheets
    a) AS 6.1: Cutting up a Chicken
    b) AS 6.2: Bratwurst Production

TEACHING PROCEDURES

A. Review

So far in this unit, an examination of processing techniques for milk and eggs has taken place. The largest industry to be studied is the meat industry.

B. Motivation

Have each student select an index card listing one of the following anatomical regions on a swine carcass: skin, ear, bone, adrenal gland, blood, brain, intestine, pituitary gland, hair, spleen, stomach, gall bladder, pancreas, and thyroid. Display TM 1.1. Display visual aids: soap, bone meal, leather article, hair conditioner, vitamins, ointment with cortisone as an ingredient, casings, glue, antacid, a brush, and dice. Include pictures or items depicting epinephrine, insulin, melatonin, and a hormone (i.e., implant). Have each student match the index card to the appropriate anatomical region on TM 1.1 and to the by-product visual aids. Answers follow:

A pineal gland - melatonin
B pituitary gland - hormones
C ear - leather articles
D hide/skin/leather - leather articles, glue
E stomach - antacid
F adrenal gland - epinephrine
G bone - bone meal, dice
H spleen
I intestine - casings
J pancreas - insulin
K gall bladder - cortisone
L hair - brush
M blood - hair conditioner
N thyroid gland - thyroxin

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the major meat animal species.

   What are the major meat animal species?

   a) Cattle - beef and veal
   b) Swine - pork
   c) Sheep - lamb and mutton
   d) Chicken and turkey - poultry
   e) Fish/shellfish

2. Discuss examples of fresh meat products? Display National Live Stock and Meat Board meat carcass posters.

   What are examples of fresh meat products?

   a) Primal cuts (wholesale)
      1) Chuck/shoulder
      2) Rib
      3) Loin
      4) Round/ham/leg
      5) Whole fish or fish fillets
      6) Whole fryers or turkeys
   b) Subprimal cuts (retail)
      1) Loin (short loin); toploin steak, tenderloin steak, T-Bone, porterhouse loin chop, butterfly chop
      2) Sirloin; sirloin steak, sirloin chop
      3) Leg (ham)/round; round steak, eye of round roast, top round steak, ham center slice, center slice
      4) Shoulder/chuck blade; 7-bone pot roast, blade roast, top blade steak, mock tender, bladesteak, blade chop
      5) Shoulder/chuck arm - arm pot roast, cross rib pot roast, short ribs, arm steak, arm picnic roast, arm chop
      6) Breast - brisket, shank cross cut, breast, riblet, spareribs, bacon, rolled breast
      7) Rib - ribeye steak, rib roast, rib chop
      8) Half or quarter portions of poultry; chicken breasts, fillets, sliced turkey breast
      9) Fish - sticks, squares, or fillets

3. Discuss examples of processed meat products. Approximately 35 percent of beef, veal, pork, and lamb produced in the U.S. is processed. Seventy-five percent of this is pork.

   What are examples of processed meat products?

   a) Sausages
      1) Fresh - fresh pork sausage
      2) Uncooked and smoked - kielbasa
      3) Cooked - braunschweiger, liverwurst
      4) Cooked and smoked - bologna, frankfurters
      5) Dry and/or semi-dry - pepperoni
      6) Fermented - salami
      7) Loaves - pickle loaf, Vienna sausage loaf
   b) Cured whole muscle cut
      1) Ham
      2) Corned beef
      3) Bacon
      4) Pastrami
      5) Pork shoulder
   c) Restructured
      1) Boneless ham
      2) Smoked, sliced beef
   d) Breaded
      1) Fish sticks
      2) Chicken patties

4. Discuss examples of meat by-products also called offal.

What are examples of meat by-products?

a) Edible (variety meats): liver, heart, tongue, brain, sweetbread, tripe, oxtail, chitterlings, mountain oysters, lard

b) Inedible

   1) Fats - soap, animal feeds, oils, fatty acids
   2) Tankage - soft tissue by-products processed in wet-rendering system
   3) Bone meal
   4) Feather meal
   5) Blood meal
   6) Fish meal
   7) Hides and pelts
   8) Adrenals - epinephrine, corticosteroids
   9) Blood - plasmin, thrombin, fertilizers, hair conditioner
   10) Brain - vitamin D_3 production, thromboplastin
   11) Gall bladder - cortisone, chenodeoxycholic acid
   12) Intestines - heparin and casings
   13) Pancreas - insulin
   14) Ovaries - estrogen, progesterone
   15) Parathyroid - hormone and protease
   16) Pineal gland - melatonin
   17) Pituitary - growth hormones, prolactin, adrenocorticotropic hormone
   18) Skin - gelatin, glue
   19) Spleen - splenin fluid
   20) Stomach - antacid
   21) Thyroid - thyroxin
   22) Hair - brushes, upholstering
   23) Feathers - pillows
   24) Bones - dice, crochet needles, buttons

F. Other activities

1. Students research and report current per capita trends in meat consumption in the U.S. Compare U.S. figures to third world countries' statistics.

2. Identify the primal cut regions on a carcass.

3. Show video, "Introduction to Meat Judging." (31 min.) available from IML. Discuss retail cuts.

G. Conclusion

The meat industry is the largest segment of the food processing industry. Beef, pork, chicken and turkey, lamb, and fish are the major meats. Meat is retailed as fresh or processed products. Meat by-products play a significant role as well.

H. Competency

List the products and by-products from meat animals.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. b

2. e
3. d
4. a
5. c
6. a
7. f
8. b
9. c
10. f
11. a
12. d
13. a
14. c
15. a
16. a
17. b
18. b
19. c
20. d
21. a
22. d
23. Beef, pork, veal, lamb, mutton, chicken, turkey, fish
24. Chuck, rib, loin, round
25. Edible - liver, heart, tongue, brain, etc.
    non-edible - fats (soaps), tankage, meat meal, etc.

J. Answers to Activity Sheets

AS 6.1

1. class discretion
2. added value
3. neck, wings, back, etc.

AS 6.2

No questions

UNIT - FOOD PROCESSING Name ____________________

Lesson 6: Products and By-Products From Meat Animals Date ____________________

EVALUATION

Match primal cuts with the appropriate subprimal cuts.

1.____ Tenderloin

2.____ Rib-eye steak

3.____ Brisket

4.____ Drumstick

5.____ Top round steak

6.____ Thigh

7.____ Blade steak

8.____ T-bone steak

9.____ Ham center slice

10.____ Arm roast

a. Whole fryer

b. Loin

c. Round/ham/leg

d. Breast

e. Rib

f. Chuck/shoulder

Circle the letter that corresponds to the best answer.

11. Subprimal cuts are usually ____ portions than primal cuts.

    a. Smaller
    b. Larger
    c. Fatter
    d. Thinner

12. What is the majority of processed meat?

    a. Veal
    b. Poultry
    c. Beef
    d. Pork

Match the example on the left with the type of processed meat on the right

13.___ Pepperoni

14.___ Boneless ham

15.___ Vienna sausage

16.___ Bratwurst

17.___ Bacon

18.___ Corned beef

19.___ Smoked, sliced beef

20.___ Fish sticks

21.___ Bologna

22.___ Chicken patties

a. Sausage

b. Whole muscle

c. Restructured

d. Breaded

Complete the following short answer questions.

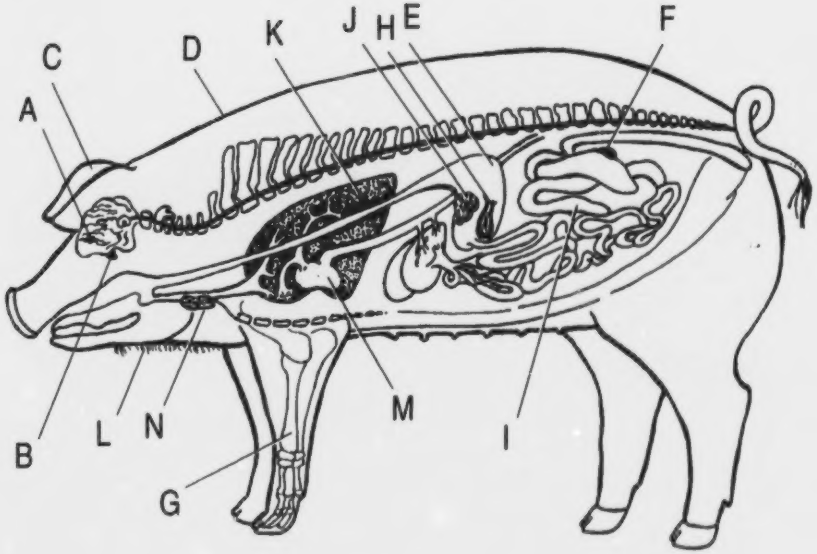
23. Name five major sources of meat.

24. What are the four primal cuts on a beef carcass?

25. Name the two classes of meat by-products and give two examples of each.

TM 6.1

Anatomical Regions on Swine



Lesson 6: Products and By-Products From Meat Animals Name ________________

Cutting Up A Chicken

Objective: Students will perform a processing technology, in this case making boneless retail cuts, that improve the efficiency of cooking.

Activity Length: 2 class periods

Background Information: Bone-in chicken parts provide food service operators with a multitude of product options. Bone-in parts can be cut in-house or purchased from processors. Because so many further processed products are available, it is important to evaluate costs carefully, considering labor requirements as well as cost per pound and cost per serving. Pre-cut parts or further processed products may be a better value.

Materials and Equipment:

Whole chicken
Sharp knife (boning knife, short chef's knife, or medium chef's knife)
Cutting board
Freezer bags
Scales

Procedure:

Cutting Tips

- Chicken should be very cold and slightly stiff for easy cutting.
- Cover and refrigerate parts as soon as they have been cut.

Cutting the Whole Body Chicken into Parts

1. Thoroughly clean work area.

2. Wash hands.

3. Remove chicken from the refrigerator or freezer. If frozen, thaw partially before cutting.

NOTE: It is easier, and safer, to cut a chicken into parts while the meat is still very cold and slightly stiff. It does not need to be completely thawed.

4. Lay chicken on its back on a cutting board with neck cavity facing away.

5. Remove giblets and neck from the chicken's body cavity.

6. Cut tail off.

7. Put chicken on its side, then forcefully pull the wing away from the body. Cut into the hollow between the breast and wing.

8. Continue pulling the wing away from the body. Cut around the wing joint.

9. Bend wing back, exposing the joint. Cut through. Repeat for other wing.

10. Separate each wing into three parts: Slice skin around joint at the small bony end. Bend back, exposing joint and cut through. Repeat for other joint.

11. Place chicken on side, then pull drumstick away from the body.

12. Cut through skin between the back and thigh.

13. Cut down to the joint where thigh connects to back.

14. Push on drumstick and thigh to open joint at the back bone and cut through. Repeat for other leg.

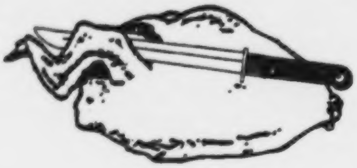
15. Find the natural fat line between the drumstick and thigh, then pull skin tightly over top of leg, feeling for a small indentation to find the joint.

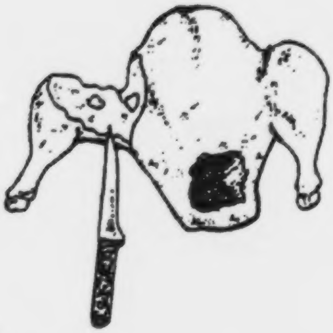
16. Lay thigh skin side down and cut through joint, bending drumstick back gently while cutting.

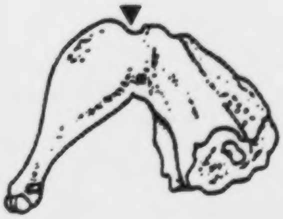
17. Stand chicken up on neck joints and locate cartilage line running down ribs.

18. Cut down ribcage to neck joints on both sides, bending the two parts away from each other tc expose the joints.

19. Cut through shoulder joints on each side and cut through skin, separating breast and backbone.







Skinning and Boning the Breast

20. Cut membrane between skin and meat. Pull off skin.
21. Start at neck cavity and cut along top edge of breast bone.
22. Cut along edge of wishbone, peeling breast from bones, leaving as little meat on the bones as possible.
23. Remove half-breast and repeat for other side.

Boning the Thigh

24. Place the thigh skin-side down. Cut down to the bone, then along the full length of the bone.
25. To free the ends, slip the knife under the bone halfway down its length.
26. Cut away from your hand, freeing one end of the bone from the flesh.
27. Turn the thigh around, lift the free end of the bone with one hand, and cut the other end free.

Key Questions:

1. What was the most difficult processing technique of this lab?

2. Why do processors debone chicken breasts and thighs?

3. What chicken parts do you think are processed into boneless breaded chicken patties?

Lesson 6: Products and By-Products From Meat Animals Name ________________

Bratwurst Production

Objective: Students will experience firsthand the processing techniques used to transfer a fresh meat into a processed meat by making an emulsion.

Activity Length: 2 periods

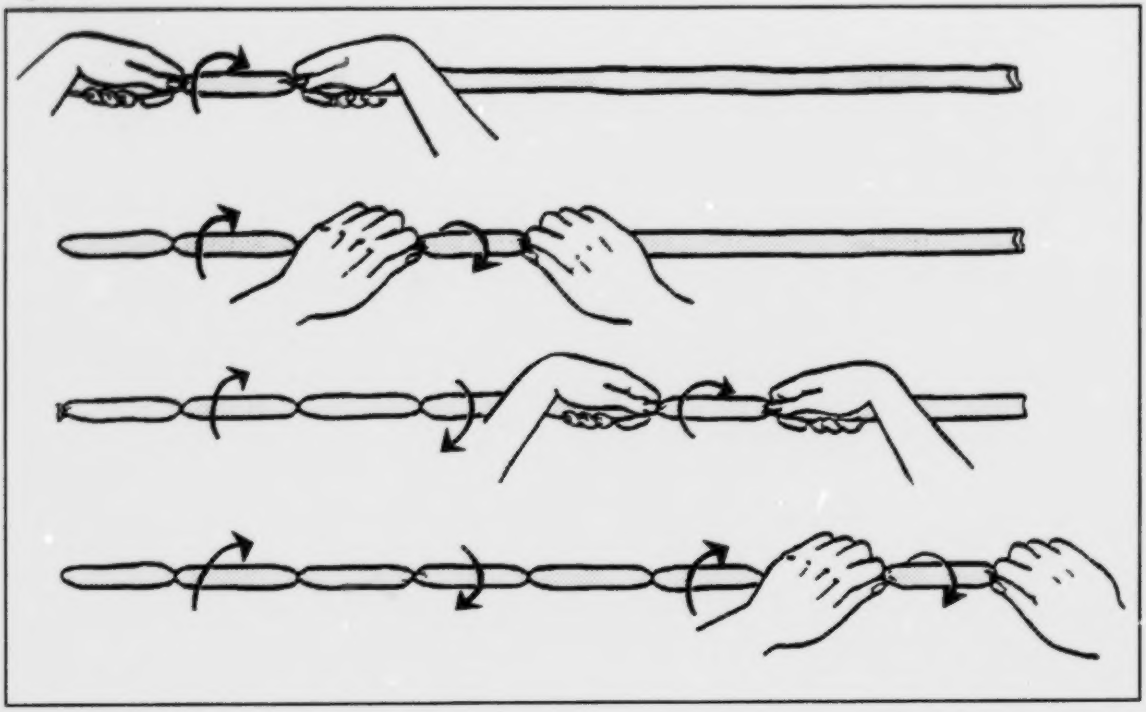
Materials and Equipment:

70%-80% lean pork
Salt
Nonfat dry milk
Water
Stove
Blender
Scale
Black pepper
Mace spice
Coriander spice
Hot mustard
Meat grinder
Cellulose casings
Stuffer (optional)

Procedure:

1. Grind 5 lbs. of 70-80 percent lean pork and place in blender.
2. Add: 1.5 oz salt
   .75 oz water
   .16 oz black pepper
   .08 oz mace
   .08 oz coriander
   .08 oz hot mustard
3. Blend for 5 minutes.
4. To complete the emulsion, add .75 oz water and 1.5 oz nonfat dry milk to the ingredients in the blender.
5. Blend for 5 minutes.
6. Place emulsion into a stuffer (a plastic funnel with a push stick will substitute).
7. Attach casing to stuffer.
8. Stuff casings.
9. Link casing see figure 6.1.

Figure 6.1



In handlinking bratwurst using a twist method, the casing can be virtually any length 1) start on one end and pinch the casing between thumb and forefinger at points 5 and 10 inches from the end. Using both hands, twist the link between your hands away from yourself; 2) pinch the casing at 5-inch intervals from the same end, except this time twist the link between your hands toward yourself 3) and 4) continue twisting every other link in the opposite direction as the preceding twist until the end of the casing is reached.

10. Cook bratwurst. Bratwurst can be pan fried, braised, broiled or grilled.

Adapted from: Romans, Jones, Costello, Carlson, Ziegler. *The Meat We Eat.* 12th ed. Danville, IL: Interstate Printers and Publishers, 1985.

UNIT II - FOOD PROCESSING

Lesson 7: Processing Meat Animals

Objective: The student will be able to describe the processing of meat animals.

Study Questions

1. **What are the steps involved in processing meat animals?**
2. **What techniques are used to process fresh meat products?**
3. **What factors affect meat quality?**
4. **How is the meat processing industry organized?**

Reference

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.

UNIT II - FOOD PROCESSING

Lesson 7: Processing of Meat Animals

TEACHING PROCEDURES

A. Review

Review the major meat animal sources.

B. Motivation

1. Rigor mortis can be observed using the sterno-mandibularis muscle from a pork or beef carcass. Obtain muscle from a local slaughter house. Cut muscle into two pieces with the grain. Nail the ends of one piece to a small board. Freeze both muscles within 20 minutes of slaughtering in its stretched position. Allow muscle to thaw. Measure the rigor mortis activity as it shortens.

2. Explain the Kosher processing method to students by explaining its history. Show students a package of meat with the Kosher meat stamp. Kosher Inspection is performed by authorized persons following the standards set forth by the Mosaic and Talmudic laws. The word Kosher means "properly prepared" in the Hebrew language. Kosher meat must come from an animal that has split hooves and chews its cud.

   The slaughter involves draining the blood and then soaking and salting each side of the meat. Salting draws out the remaining blood as it is required by biblical law. (Leviticus 7:14) "You shall not eat the blood of any creature for the life of every creature is its blood."

C. Assignment

D. Supervised Study

E. Discussion

1. Discuss the steps of processing meat animals.

   What are the steps involved in processing meat animals?

   a) Cattle
      1) Immobilization
      2) Rodding the weasand
      3) Heading
      4) Shanking
      5) Siding
      6) Evisceration
      7) Splitting
      8) Refrigerating
      9) Inspecting
      10) Grading
   b) Hogs
      1) Immobilization, stunning and sticking
      2) Scalding/skinning
      3) Hair and scurf removal

        4) Skinning
        5) Head removal
        6) Evisceration
        7) Splitting
        8) Inspection
        9) Refrigeration
        10) Grading
    c) Lambs
        1) Immobilization, stunning, and exsanguination
        2) Pelting
        3) Head removal
        4) Separate esophagus and trachea
        5) Evisceration
        6) Refrigeration
        7) Inspection
        8) Grading
    d) Poultry
        1) Immobilization and sticking
        2) Defeathering - scalding and defeathering or dry-picking
        3) Chilling
        4) Evisceration
        5) Grading
    e) Fish
        1) Remove head behind gills
        2) Descale
        3) Remove tail
        4) Remove entrails
        5) Rinse and chill

2. Discuss what techniques are used to process fresh meat products. The majority of processed meat is shipped in a box as either quarters, primal cuts, or subprimal cuts. Lamb carcasses are normally shipped whole.

    What techniques are used to process fresh meat products?

    a) Carcass size reduction
        1) Beef - quartering: cut between 12th & 13th ribs: 52 percent weight in forequarters, 48 percent weight in rearquarters
        2) Lamb - whole
        3) Veal - fore and rear saddles
        4) Pork - complete subprimal processing
    b) Primal (wholesale) cuts fabrication
    c) Subprimal (retail) cut fabrication
        1) Roast
        2) Steak/chop
        3) Ground meat
    d) Deboning
    e) Pattie production
    f) Shelf-life extension - refrigeration is the most popular
    g) Tenderization - mechanical, enzymatic
    h) Control of composition by restructuring
    i) Portion control

3. Discuss what factors affect meat quality.

What factors affect meat quality?

a) Production-related factors
    1) Age of animal
    2) Health of live animal
    3) Nutrition of live animal
    4) Sorting and hauling of live animal
    5) Heredity
b) Processing related factors
    1) Sanitation of processing plant
    2) Efficient immobilization and proper exsanguination
    3) Postmortem temperature
    4) Postmortem handling
    5) Processing sanitation
    6) Water holding capacity
    7) Color control

4. Discuss how the meat processing industry is organized.

How is the meat processing industry organized?

a) Poultry - vertical integration
b) Pork - some vertical, some independent
c) Lamb & beef - mostly independent
d) National Live Stock and Meat Board, National Broiler Council and National Turkey Federation represent producers, processors, and retailers in product research, education, and promotion.

F. Other activities

1. Show a video on slaughtering.

2. Taste test tenderized flank steak versus non-tenderized.

G. Conclusion

The process of transforming a meat animal into retail steaks, roasts, burgers, etc., is complex. Beef, veal, pork, lamb, mutton, and poultry products all undergo inspection and grading before they reach the retail meat case. Fish, on the other hand, are not required to be inspected. Meat quality is a concern of all and is determined by production techniques, genetics and processing factors.

H. Competency

Describe the processing of meat animals.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. _6_ Grading
   _1_ Stunning
   _4_ Eviscerating
   _5_ Refrigerating
   _2_ Sticking
   _3_ Skinning

2. d
3. e
4. b
5. c
6. a
7. Compare: both are scalded to denature proteins. Contrast: pork scalding loosens hairs, poultry scalding loosens feathers.
8. Its thickness - steak 3/4 - 1", roast 2" or more.
9. The younger the animal, the more tender its muscle.

10. Stress causes higher temperatures, reduced pH and early rigor mortis onset. It can result in PSE meat.

11. National Live Stock and Meat Board
    National Broiler Council
    National Turkey Federation

UNIT II - FOOD PROCESSING　　Name ______________________

Lesson 7: Processing of Meat Animals　　Date ______________________

EVALUATION

1. Place the following beef processing steps in the correct order by placing numbers in the blanks to indicate which step comes 1st, 2nd, 3rd, etc.

___ Grading
___ Stunning
___ Eviscerating
___ Refrigerating
___ Sticking
___ Skinning

Match the carcass size reduction technique with the type of meat animal.

___ 2. Veal　　a. Whole or pre-cut
___ 3. Beef　　b. Whole
___ 4. Lamb　　c. Complete subprimal processing
___ 5. Pork　　d. Fore and rear saddles
___ 6. Poultry　　e. Quartering

Complete the following short answer questions.

7. Compare and contrast the scalding of hogs versus poultry.

8. What is the basic difference between a steak and a roast?

9. How can an animal's age affect its meat quality?

10. How can stress on an animal affect its muscle character?

11. What national organizations represent the meat industry?

Lesson 8: Quality Grades, Inspections, and Brand Names in Meat Industry

Objective: The student will be able to explain the relationship between quality grades, inspections, and brand names in the meat industry.

Study Questions

1. **Who is responsible for inspecting and grading meat?**
2. **Why are some meat products not inspected?**
3. **What are the quality grades of meat?**
4. **What does a meat inspector look for in a meat inspection?**
5. **What is the difference between USDA quality grades and processors' brand names?**

Reference

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.

Lesson 8: Quality Grades, Inspections, and Brand Names in Meat Industry

TEACHING PROCEDURES

A. Review

Review the factors that affect meat quality. These determine the grades which are explained in this lesson.

B. Motivation

Bring a complete package/label from a fresh cut of meat. Point out the inspection and quality grade stamp. Pre-test their knowledge of what these stamps indicate. Which stamp assures quality? Which stamp dictates price/pound?

C. Assignment

D. Supervised study

E. Discussion

1. Discuss who is responsible for inspecting and grading meat.

   Who is responsible for inspecting and grading meat?

   a) Inspection
      1) Qualified USDA inspectors
      2) Kosher inspectors - also must meet USDA standards
   b) Grading - qualified USDA meat graders, paid for with other processing costs

2. Discuss why some meat products are not inspected.

   Why are some meat products not inspected?

   a) Laws do not require fish sold in the U.S. to be inspected.
   b) Laws do not require meat processed "not for sale" to be inspected.
   c) Squabs, gamebirds, rabbits, and most wild game are exempt from the law.

3. Discuss the quality grades of meat. See student reference for quality grade factors.

   What are the quality grades of meat?

   a) Beef - young
      1) Prime
      2) Choice
      3) Select
      4) Standard
   b) Beef - old
      1) Commercial
      2) Utility
      3) Cutter

        4) Canner
    c) Veal
        1) Prime
        2) Choice
        3) Good
        4) Standard
        5) Utility
        6) Cull
    d) Pork
        1) Acceptable
        2) Utility
    e) Sheep
        1) Lamb
            (a) Prime
            (b) Choice
            (c) Good
            (d) Utility
        2) Yearling mutton
            (a) Prime
            (b) Choice
            (c) Good
            (d) Utility
        3) Mutton
            (a) Choice
            (b) Good
            (c) Utility
            (d) Cull
    f) Poultry
        1) Grade A
        2) Grade B
        3) Grade C

4. Discuss what a meat inspector looks for during a meat inspection.

What does a meat inspector look for in a meat inspection?

a) Unwholesome or adulterated carcasses
b) Sanitary processing
c) Honest labeling
d) Correct temperatures
e) Correct use of additives
f) Lab analysis

5. Discuss the difference between a USDA quality grade and processors' brand names.

What is the difference between USDA quality grades and processors' brand names?

a) Quality grade - shield shaped stamp with purple ink.
b) Different brand names may designate different grades, but they will be different from one company to another.

F. Other activities

1. Require each student to acquire an inspection/grading label and explain what it means.

2. Taste test different brand names of the same meat cut to determine the brand name/quality grade association.

3. Visit a packing house and observe the inspector/grader at work.

4. Show a video on meat inspection, meat judging, or meat evaluation. Several videos are available form Nasco Agricultural Sciences catalog, 1-800-558-9595.

5. Order National Live Stock & Meat Board Marbling photos. Study photos and correct quality grade associated with each. Also, measure the L.E.A. using a grid on a pork loin.

G. Conclusion

Beef, Pork, Lamb and Poultry products are inspected by USDA or Kosher inspectors. Quality grading is completed by qualified USDA meat graders. Some meat products are not inspected and these include fish, "Not for sale" meat, rabbits, gamebirds, etc. Beef grades include prime, choice, select, standard, commercial, utility, cutter, and canner. Pork is graded as acceptable and utility. Poultry grades are A, B, and C. Meat inspectors carefully examine a number of factors before placing their approval stamp on the carcass. Finally, brand names and quality grades are not the same.

H. Competency

Explain the relationship between quality grades, inspections, and brand names in the meat industry.

Related Core Competencies and Key Skills: None

I. Answers to Evaluation

1. c
2. a
3. c
4. a
5. b
6. d
7. a
8. c
9. b
10. Prime, Choice, Select, Standard, Commercial, Utility, Cutter, Canner

11. Purple

12. Sanitary processing; honest labeling; correct temp; lab analysis; correct use of additives

13. disjointing, broken bones, broken skin, bruised, pin feathers, conformation, fleshing, fat covering

UNIT II - FOOD PROCESSING

Name ____________________

Lesson 8: Quality Grades, Inspections, and Brand Names in Meat Industry

Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Who is responsible for meat inspection?

   a. U.S. Department of Health
   b. National Live Stock and Meat Board
   c. Food Safety and Inspection Services
   d. State of Missouri

2. A young steer carcass might grade:

   a. Prime
   b. Good
   c. Commercial
   d. Utility

3. An old cow's carcass may grade:

   a. Prime
   b. Choice
   c. Utility
   d. Good

4. Pork quality grades are:

   a. Acceptable and Utility
   b. Prime and Choice
   c. Grades A, B, or C
   d. Good and Standard

5. Veal carcasses are quality graded on:

   a. Size
   b. Color
   c. Texture
   d. Parts

6. Which of the following is not a quality grade of a lamb?

   a. Prime
   b. Choice
   c. Good
   d. Cull

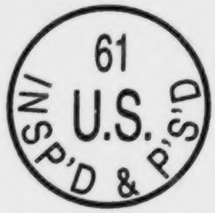
Match the stamp on the right with what it stands for on the left.

_____ 7. Inspected and passed

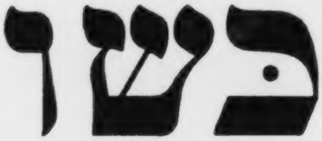
_____ 8. Quality grade stamp

_____ 9. Kosher stamp

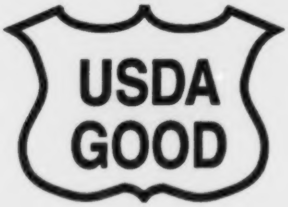
A.



B.



C.



Complete the following short answer questions.

10. List the eight carcass quality grades for beef.

11. What color ink is used for inspection and grading stamps?

12. List two factors a meat inspector looks for in a meat inspection.

13. Name one factor that could lower a poultry carcass from Grade A to a Grade B carcass.

Lesson 9: Products from Grain Crops

Objective: The student will be able to identify the products of grain crops.

Study Questions

1. **What primary grains are used for food products?**
2. **What are the primary food products of grain crops?**
3. **What by-products are produced from grain crops?**
4. **What non-food products are produced from grain crops?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.
2. Activity Sheets
    - a) AS 9.1: Soybean Processing
    - b) AS 9.2: Corn Sweeteners

UNIT II - FOOD PROCESSING

Lesson 9: Products from Grain Crops

TEACHING PROCEDURES

A. Review

Meat carcasses are individually inspected and graded before they can be processed and/or sold commercially. Grain, on the other hand, is graded in very large quantities, or batches, before processing.

B. Motivation

Bring several snack foods made from different grain crops. Have students identify which grain was used to make the food product. (e.g., crackers, cookies, breakfast cereals)

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the primary grains used for food products.

What primary grains are used for food products?

a) Cereal grains
    1) Wheat
    2) Corn
    3) Oats
    4) Barley
    5) Rice
    6) Rye
    7) Grain sorghum
    8) Buckwheat
b) Oil-bearing grains
    1) Soybean
    2) Peanut
    3) Sunflower
    4) Cottonseed
    5) Canola (rapeseed)
c) Dry legumes
    1) Dry peas
    2) Beans - navy, pinto, black, etc.
    3) Lentils

2. Discuss with students what primary food products come from grain crops. Have students complete AS 9.1.

What are the primary food products of grain crops?

a) Cereal grains

            1) Wheat
                (a) Hard - Durum - pasta, breadmaking
                (b) Soft - cake and cookie flour
            2) Corn
                (a) Whole - popcorn
                (b) Milled - meal, flour, starch, oil, syrup (sweeteners)
            3) Oats - flour or rolled, bran
            4) Barley - malt, flour, whole
            5) Rice - most important human food
                (a) Flour, whole
            6) Rye - flour
        b) Oil-bearing
            1) Soybean - 20 percent oil, 44-48 percent protein
                (a) Soy flour, soy milk, tofu (soy cheese), soy sauce, lecithin
            2) Sunflowers - whole (dried) or 50 percent oil
            3) Peanut - roasted whole, peanut butter
            4) Canola - (rapeseed) - oil
        c) Dry legumes
            1) Dried peas and beans - protein rich, low in oil

3. Discuss with students what by-products are produced from grain crops. These by-products are used in livestock feeds and pet food. Have students complete AS 9.2.

What by-products are produced from grain crops?

a) Wheat bran
b) Corn gluten
c) Rice hulls
d) Germ
e) Distiller's grain
f) Peanut hulls
g) Midlings

4. Discuss with students what non-food products are produced from grain crops.

What non-food products are produced from grain crops?

a) Corn - corn starch/biodegradable plastic, diapers, packing nuts, ethanol, paper production, encapsulated herbicides, etc.
b) Soybean - soy diesel, soy ink, new stone, paints, magnetic media, leather softener, rust inhibitors, lubricants, paper coating, dust inhibitor, etc.
c) Peanut - hulls used as "cinders" on slick roads, etc.

F. Other activities

1. Soak wheat or corn until soft and dissect the seeds to examine the bran, endosperm, and germ.

G. Conclusion

Grains that are processed into food are classified as cereal grains, oil-bearing grains, and dry legumes. A variety of food products ranging from pasta, flour, and bran to soy milk and peanut butter are derived from grains. As food grains are processed, a variety of by-products result that often become livestock feed. In addition to by-products, several non-food products are produced from these food grains.

H. Competency

Identify the products of grain crops.

Related Core Competencies and Key Skills: none

I. Answers to Evaluation

1. c
2. a
3. a
4. a
5. b
6. b
7. c
8. a
9. a
10. b
11. a
12. b
13. d
14. a
15. protein, oil
16. Hard wheat - bread and pasta making, soft wheat - cake and cookie flour
17. Popcorn, rice, rolled oats, roasted soybeans, and others as appropriate
18. Wheat bran, corn gluten, rice hulls, germ, distiller's grain, and others as appropriate
19. Teacher's discretion

J. Answers to Activity Sheets

AS 9.1 - Instructor's discretion
AS 9.2 - Instructor's discretion

UNIT II - FOOD PROCESSING

Lesson 9: Products from Grain Crops

Name ____________________

Date ____________________

EVALUATION

Match the grain on the left with its proper category on the right.

1.________ Pinto beans

2.________ Wheat

3.________ Corn

4.________ Rye

5.________ Peanuts

6.________ Sunflowers

7.________ Dried peas

8.________ Rice

9.________ Barley

10.________ Soybeans

11.________ Oats

12.________ Canola

a. Cereal grain

b. Oil-bearing grain

c. Dry legume

Circle the letter that corresponds to the best answer.

13. What grain is eaten more than any other?

    a. Soybeans
    b. Corn
    c. Barley
    d. Rice

14. Soybeans are _____ percent oil and _____ percent protein.

    a. 20, 44-48
    b. 40, 8-12
    c. 40, 16-20
    d. 44-48, 20

15. Dried beans are high in _______________ and low in ______________________________.

    a. Starch, protein
    b. Oil, protein
    c. Protein, starch
    d. Protein, oil

16. Explain the primary way hard wheat is used versus soft wheat.

17. Give two examples of whole grain products used for food.

18. List three examples of by-products from processing food grains.

19. Write a short essay on non-food products made from corn and soybeans. Include plastics, ink, ethanol, and soy diesel in your discussion.

Lesson 9: Products from Grain Crops

Name ________________

Soybean Processing

Objective: Process the soybean into an edible food product.

Activity Length: Overnight soak, 1 hour dry time, 1 lab period

Materials and Equipment:

Soybeans, dry (must be cleaned)
Water
Quart oil for frying
Salt
Deep fat fryer
Paper towels

Procedure:

1. Clean soybean sample by removing all foreign material and washing thoroughly.

2. Soak soybeans in water overnight.

3. Drain beans thoroughly. The skins may be removed if desired. Place beans on absorbent paper and allow to air-dry about one hour. (Your instructor may have done this step for you.)

4. Place oil in a deep fat fryer or a heavy, deep saucepan. Heat oil to 350°F.

   CAUTION: Oil is very hot. Be careful when working around the heated oil.

5. Put about 1 cup beans in a fryer basket. Lower basket slowly into the hot fat. Moisture in beans may cause excessive splattering if beans are lowered rapidly into the fat.

6. Fry beans about 6 to 8 minutes or until crisp and lightly browned.

7. Remove from oil.

8. Drain beans on absorbent paper.

9. Sprinkle with salt.

10. When cool, sample. The remaining beans should be stored in a tightly covered container.

Credit: The Missouri Soybean Association and the Missouri Soybean Merchandising Council, P.O. Box 104778, Jefferson City, MO 65110-4778.

Lesson 9: Products from Grain Crops Name ________________

Corn Sweeteners

Objective: Identify corn sweeteners used in snack foods.

Background Information: Wet-milling of corn yields several corn sweeteners. Corn syrup, fructose, dextrose, and dextrin are the most common. As you investigate food products and the corn sweeteners used in them, you will gain a greater appreciation of how important grains are to American tastes and eating habits.

Procedure: Examine ten packages, bottles, or boxes of snack foods. List the product by brand name and the sweetener or sweeteners used.

	Product	Sweetener(s)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

UNIT II - FOOD PROCESSING

Lesson 10: Processing of Grain Crops

Objective: The student will be able to explain the processing of grain crops.

Study Questions

1. **What are the steps in processing grain crops?**
2. **What techniques can be used to preserve grain products?**
3. **Why is grain inspected?**
4. **What factors are considered in grading grain?**
5. **How are the different grades of grain used?**
6. **What is the structure of the food grain industry?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.
2. Activity Sheet
   a) AS 10.1 Processing Wheat

Lesson 10: Processing of Grain Crops

TEACHING PROCEDURES

A. Review

Review the leading food grains. Relate to the class that only a small percentage of these grains are consumed as "whole grain." Most grains are milled before they reach the supper table. This lesson examines the processing of grains.

B. Motivation

1. Blindfold two students, and have them taste several breakfast cereals to try to identify the cereal name. Record their responses. You may want to taste whole grain corn, wheat, and oats, in addition. How successful were the students in identifying what they were eating? Relate how extrusion improves the texture of these grains.

2. Give an overview of the history of grain marketing. The following information is a synopsis from "Historical Facts about Grain Marketing" from the Cooperative Extension Service.

   Pure food and market inspectors existed in Athens in 400 B.C.

   In 1625, which was five years after the Mayflower landed, a shipload of corn was exchanged for 700 pounds of furs.

   Wheat was used as legal tender for taxes, whereas Indian Corn was legal tender for debts in 1631. In 1640 wheat was established in New England and shipments were made between colonies. The U.S. imported grain from 1835-1837 because of early frosts and poor production. Then the Ohio and Erie canals were opened. A barrel of flour brought $3 in 1826 and $6 in 1835. Corn went from 12 to 20 cents per bushel in that same time period.

   In 1848 the Chicago Board of Trade was established. In 1857 a Grain Inspection Department was established in Chicago. The Chicago Board of Trade set up the first grain standards using numerals for wheat, corn, oats, and barley. In 1869, the Kansas City Board of trade was reorganized.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the steps in processing grain crops. Have students complete AS 10.1. The instructor may wish to have several types of grains for students to process.

   What are the steps in processing grain crops?

   a) Harvest
   b) Transport
      1) rail
      2) barge

    3) truck
c) Milling - cereal grains
    1) Dry milling - remove foreign seeds and soil; condition to proper moisture; separate germ, bran (hull), endosperm; grind, roll and sieve
    2) Wet milling - water slurry used to separate germ, bran, and endosperm
d) Malting - germinate barley seeds to activate enzymes
e) Roasting - oil seeds
    1) Grains are steamed and crushed to expose oil
f) Enrichment and fortification
g) Extrusion

2. Discuss what techniques can be used to preserve grain products.

What techniques can be used to preserve grain products?

a) Drying below 14 percent - grains, meals, flours, pasta
b) Regulating osmotic pressure - syrups with high sugar content
c) Irradiation - destroys any insects, molds, bacteria

3. Discuss why grain is inspected. The quality of the whole can be no better than the sum of its parts.

Why is grain inspected?

a) To determine its quality/wholesomeness
b) To establish a price

4. Discuss what factors are considered when grading grain. Recall that grain is graded to determine its quality and therefore its destination. Also, a fair price must be established based on its quality.

What factors are considered in grading grain?

a) Test weight
b) Moisture
c) Damaged/split grains
d) Heat damaged grains
e) Foreign material
f) Diseased/treated kernels

5. Discuss how the different grades of grain are used. The lower the grade number, the higher the quality. Naturally, the highest quality will be used for human food while the lower quality is used for animal feed.

How are the different grades of grain used?

a) Grades U.S. #1 and #2 are suitable for human food processing.
b) Grades U.S. #3, #4, #5 and sample grade are processed for animal feed. They may be upgraded with U.S. #1 grain to meet U.S. #2 standards, depending on reason for initial grade.

6. Discuss the structure of the food grain industry.

What is the structure of the food grain industry?

a) Very diverse; ranges from multi-million dollar conglomerates to local processing businesses
b) Kansas City Board of Trade - wheat sales
c) Chicago Board of Trade - multi-grain sales
d) Contract growers - raise specific varieties for specific mills

F. Other activities

1. Using the flour processed in AS 10.1, make bread, biscuits, or other products. Discuss why and how the end products differ.

2. Visit a local grain elevator and examine the grain grading equipment and run a sample.

3. Invite a local grain grader to speak to class about his/her job.

4. Display samples of different grades of grain. See if students can tell which grade is which.

G. Conclusion

A vast majority of grains are processed before consumption. A part of this processing is the preservation process accomplished by drying, irradiating, or regulating osmotic pressure. Grain is graded to establish a fair price and to determine its future use. Several factors of grain quality determine its grade.

H. Competency

Explain the processing of grain crops

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. a
2. c
3. d
4. To replace vitamins and minerals lost during milling.
5. Four of the following: moisture, test weight, damaged/split kernels, heat damage grain, foreign material, diseased/treated kernels
6. Teacher's discretion

J. Answers to Activity Sheet

AS 10.1

Instructor's discretion

Name ____________________

Lesson 10: Processing of Grain Crops Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. On which grain is the malting process used?

   a. Barley
   b. Corn
   c. Soybean
   d. Wheat

2. What are two of the methods used to preserve grain products?

   a. Moisture below 20%, high salt content
   b. Moisture below 20%, high sugar content
   c. Moisture below 14%, high sugar content
   d. Moisture below 14%, low sugar content

3. Which U.S. grades of grain are the primary source for food grain products?

   a. Grades 5 and sample
   b. Grades 4 and 5
   c. Grades 3 and 4
   d. Grades 1 and 2

Complete the following short answer questions.

4. Why are certain grains enriched?

5. List 4 of the factors used to evaluate grain in grading.

6. Compare the Kansas City Board of Trade and the Chicago Board of Trade based on what crop(s) they trade.

Lesson 10: Products from Grain Crops

Name ________________

Processing Wheat

Objective: Process wheat into flour.

Activity Length: 1 period

Materials and Equipment:

1 pound wheat grain (You may substitute oat, rye, and barley.)
Steel- or stone-wheel grinder
Bowl to receive flour
Scales

Procedure:

1. Read manufacturer's instructions for operating the grinder.
2. Weigh the bowl and record the weight or set the scale to the weight of the bowl.
3. Weigh out one pound of grain. Record in Table 10.1.
4. Tightly secure the grinder to a bench or table.
5. Place grain where it can be easily reached and bowl where it will receive the flour from the grinder.
6. Place grain in receiving hopper according to manufacturer's directions.
7. Turn crank slowly, with a steady pressure.
8. Continue grinding until all grain is ground.
9. Weigh flour. Record in Table 10.1.

Table 10.1

Type of Grain Used	Weight of Grain	Weight of Flour

Key Questions:

1. Does the flour look like flour purchased from the store? Why or why not?

2. Did the pound of grain equal one pound of flour? Why or why not?

Lesson 11: Fruit, Vegetable, and Nut Products

Objective: The student will be able to identify fruit, vegetable, and nut products and factors that determine quality.

Study Questions

1. **What are the major classes of fruits, vegetables, and nuts?**
2. **What are the products from fruits, vegetables, and nuts?**
3. **What factors determine quality of fruits, vegetables, and nuts?**
4. **What are the by-products of fruits, vegetables, and nuts?**
5. **What crop characteristics influence how they are used?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.
2. Activity Sheet
   a) AS 11.1: Nut Butter

Lesson 11: Fruit, Vegetable, and Nut Products

TEACHING PROCEDURES

A. Review

Grain crops are graded for quality. Similarly, fruits, vegetables, and nuts are graded. Review the variables that are examined when grading grain, and relate them to the variables examined for grading fruits and vegetables.

B. Motivation

1. Display examples or illustrations of different varieties of fruits, vegetables, and nuts (i.e., pear tomatoes, cherry tomatoes, slicing tomatoes). Have students explain why each variety is important. Relate variety types to market niche.

2. Have a grocery store produce manager give a presentation (pear tomatoes - ketchup tomato, cherry-color and size, slicing tomatoes-shape).

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the major classes of fruits, vegetables, and nuts.

What are the major classes of fruits, vegetables, and nuts?

a) Fruits
    1) Melons - cantaloupes, watermelons
    2) Drupes (single pits) - apricots, cherries, peaches, plums
    3) Berries - grapes, cranberries
    4) Pomes (many pits) - apples, pears
    5) Citrus - oranges, grapefruits, lemons
    6) Tropical - bananas, dates, figs, pineapples, mangos, papayas
b) Vegetables
    1) Earth vegetables - sweet potatoes, onions, potatoes
    2) Herbage vegetables - cabbage, spinach, lettuce, celery, rhubarb
    3) Fruit vegetables - peas, green beans, sweet corn, squash, tomato
c) Nuts
    1) Cultivated tree nuts
    2) Wild nuts

2. Discuss the products from fruits, vegetables, and nuts. Have students complete AS 11.1.

What are the products from fruits, vegetables, and nuts?

a) Fresh - melons, bananas
b) Frozen - corn, lima beans, strawberries
c) Juices - apple, grape, orange

d) Canned - peaches, peas
e) Purees - baby food, tomato sauce
f) Processed - applesauce, cranberry sauce
g) Jellies/jams
h) Dried fruits and vegetables
i) Nut meats
j) Shell nuts
k) Cracked nuts
l) Roasted nuts

3. Discuss the factors that affect quality grades.

What factors determine quality of fruits, vegetables, and nuts?

a) Maturity
b) Instrumental evaluation
c) Color
d) Size
e) Shape
f) Firmness/texture
g) Aroma
h) Variety
i) Harvesting method
j) Acid concentration
k) Sugar to acid ratio
l) Physical damage/disease

4. Discuss fruit, vegetable, and nut by-products.

What are the by-products of fruits, vegetables, and nuts?

a) Rinds/peels/shells
b) Pits
c) Non-juice solids

5. Discuss the crop characteristics that influence how the produce is used.

What crop characteristics influence how they are used?

a) Time of maturity and yield
b) Weather response
c) Pest and disease resistance
d) Shape
e) Size
f) Resistance to physical damage
g) Storage stability
h) Suitability to certain processing methods
i) Color of flesh
j) Firmness when cooked and raw
k) Amount of juice
l) Acidity level
m) Solids content

F. Other activities

1. Canning grape juice - Remove grapes from stems. Wash sound, ripe grapes. Cover them with water and heat slowly to a simmer - do not boil. Cook slowly until the fruit is very soft. Then strain the grapes through a bag - separating the juice from the pulp. Add 1/2 cup of sugar to each quart of juice. Pour juice into sterile jars and process 15 minutes (pressure cook or retort) in boiling water bath.

G. Conclusion

Classification of fruits, vegetables, and nuts is based on their origin, anatomy, and/or how they are eaten. These produce types are quality graded and create a variety of by-products.

H. Competency

Identify fruit, vegetable, and nut products and factors that determine quality.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. h
2. f
3. g
4. a
5. c
6. d
7. e
8. i
9. b

10. In-shell, cracked, nut meats, roasted

11. Rinds, peels, shells, non-juice solids

12. Instructor's discretion

J. Answers to Activity Sheet

AS 11.1

1. To remove the skin
2. Answers will vary
3. Answers will vary

UNIT II - FOOD PROCESSING

Lesson 11: Fruit, Vegetable, and Nut Products

Name ______________________________

Date ______________________________

EVALUATION

Match the class of fruit, vegetable, or nut on the left with an example on the right.

___1. Earth vegetable

___2. Herbage vegetable

___3. Fruit vegetable

___4. Melons

___5. Drupes

___6. Berry

___7. Pomes

___8. Citrus

___9. Tropical

a. Honeydew

b. Banana

c. Cherry

d. Blackberry

e. Apple

f. Celery

g. Pea

h. Onion

i. Grapefruit

Complete the following short answer questions.

10. Name three products from nuts.

11. List two by-products of fruit, vegetable, and nut processing.

12. Essay - Assume you live near a tomato juice processing plant. You have contracted to raise tomatoes for this plant next year. Write a paragraph using each of the following characteristics: shape, size, color, juice, content, and storage stability to describe the variety of tomatoes you will likely raise.

AS 11.1

Lesson 11: Fruit, Vegetable, and Nut Products

Name ____________________

Making Nut Butter

Objective: To process a nut by pressing out its oil and producing a nut butter.

Activity Length: 1 period

Materials and Equipment:

¼ c. Pecans, walnuts, almonds, etc. (raw)
Nut grinder
Rolling pin
Plastic bags
Knife
Water
Small pan used to heat almonds
Salt

Procedure:

1. Select one type of nut to process.

2. Grind or crush nut meats.

    a. If using pecans or walnuts, dice nuts and place through a nut grinder or use a double plastic bag and rolling pin to reduce the particle size.

    b. If using almonds or peanuts, place in pan, cover with water, and boil for 5 minutes. Then remove skin. Grind with a nut grinder or crush with a rolling pin while in a double plastic bag.

3. Place in a plastic-bag and roll with rolling pin exerting as much pressure as possible to squeeze out oils.

4. As oil is pressed out, nut particles will cling together to form a "butter."

5. Lightly salt.

6. Examine your butter and complete Table 9.1. Also, check with students who processed different nuts and record your opinions in the table.

Table 11.1 Nut Butter Qualities

Type of Nut	Color of Butter	Rank in order of Oil Content	Spreading Qualities	Taste Preference

Key Questions:

1. Why do you need to boil the almonds or peanuts before they are crushed?

2. How do the different nut butters compare?

3. Which nut butter had the best flavor?

UNIT II - FOOD PROCESSING

Lesson 12: Processing Fruits, Vegetables, and Nuts

Objective: The student will be able to explain how fruits, vegetables, and nuts are processed.

Study Questions

1. **How are fruits, vegetables, and nuts processed?**
2. **How do processing techniques affect the nutritional value of fruits, vegetables, and nuts?**
3. **How are fresh fruits, vegetables, and nuts treated and packaged to enhance their appearance and shelf life?**
4. **How is the industry that processes fruits, vegetables, and nuts organized?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit II.
2. Activity Sheets
    a) AS 12.1: Enzymatic Browning

UNIT II - FOOD PROCESSING

Lesson 12: Processing Fruits, Vegetables, and Nuts

TEACHING PROCEDURES

A. Review

Review the major classes of fruits, vegetables, and nuts. Ask your students to name an example of each. Compare these raw products to what is found in the grocery store. Would any fruit, vegetable, or nut require processing?

B. Motivation

The "Love Apple" .... what is it? It is a fruit, but gets treated like a vegetable. It is a perennial, but gets treated like an annual. It was probably domesticated in Mexico and arrived in Europe in the 1500's. Thomas Jefferson, a gardener ahead of his time, raised it. Robert Gibbon Johnson is slightly famous because he ate one on the courthouse steps in Salem, NJ, in 1820. It was believed to be poisonous due to the family from which it came, the nightshade family. It supplies vitamins A an C. It normally self pollinates. It provides the pizazz on pizza, sauce for spaghetti, base for soup, garnish on a salad, and main ingredient in catsup. What is it? Tomato ref. Credit: Rick, Charles M. *Science of Food & Agriculture*, Jan. 1986.

C. Assignment

D. Supervised Study

E. Discussion

1. Discuss how fruits, vegetables, and nuts are processed.

How are fruits, vegetables, and nuts processed?

a) Fruits and vegetables
    1) Harvest
    2) Transported to plant
    3) Cleaned and sorted
    4) Some go to a ripening chamber
    5) Additional processing depends on end product
        (a) Fresh - cooled, washed
        (b) Frozen - washed, pitted, stemmed, cut or cored before freezing; some may be blanched
        (c) Canned - blanched, peeled and/or cored, filled in cans, air removal, sealed, retorted, cooled, and labeled.

b) Nuts
    1) Harvest with mechanical tree shaker
    2) Hulled by mechanical nut hullers
    3) Sorted by size and/or color
    4) Dried to 9.5 percent moisture
    5) Additional processing depends on end product
        (a) Nut meats - remoistened, shelled, and packaged
        (b) In-shell nuts - washed, polished, and waxed

(c) Roasted nuts - heated in oil, oil coated, salted, and oiled again (Dry roasted are heated without oil.)

2. Discuss how processing techniques affect the nutritional quality of fruits, vegetables, and nuts.

How do processing techniques affect the nutritional value of fruits, vegetables, and nuts?

a) Fresh fruits/vegetables are highest in overall nutrition.
b) Frozen items are a close second.
c) Canned items lose minerals and vitamins - canning extends the processing period but some minerals and vitamins are lost.
d) Dried fruits are devoid of Vitamin C.
e) The composition of nuts is not usually affected by processing.

3. Discuss how fruits, vegetables, and nuts are treated and packaged to enhance their appearance and shelf life.

How are fresh fruits, vegetables, and nuts treated and packaged to enhance their appearance and shelf life?

a) Ethylene gas - ripening agent
b) Sodium bisulfite - retards browning
c) Sulfur dioxide - retards browning
d) Waxing - prevents dehydration in apples and nuts
e) Irradiation - inhibits sprouting in potatoes
f) Cool temperatures - slows enzymatic reactions
g) Nuts in opaque containers - prevents rancid flavors
h) Fruits and vegetables stored in containers with holes to allow for respiration
i) Artificial coloring - enhances eye appeal

4. Discuss the organization of the fruit, vegetable, and nut industry.

How is the industry that processes fruits, vegetables, and nuts organized?

a) Contract production
b) Cooperatives
c) Very large parent companies
d) Immigrant, migrant labor
e) Organizations promote products

F. Other activities

1. Effect of roasting upon color, flavor, and texture of peanut butter.

G. Conclusion

Fruits, vegetables, and nuts are processed to maintain a steady supply in the off season. Following harvesting, fruits, vegetables, and nuts undergo different processing techniques depending on the end product. In general, the nutritional quality is highest in raw fruits and vegetables. Various techniques are used to enhance shelf-life and market value.

H. Competency

Explain how fruits, vegetables, and nuts are processed.

Related Missouri Core Competencies and Key Skills:

9D-5: Describe the relationship between technologies which improve our lives and the environmental problems that can result from them.
9D-6: Identify the control, dependent, and the independent variables in an experiment.

I. Answers to Evaluation

1. e
2. b
3. a
4. c

5. 3
   1
   2

6. Contract production - growers supply processors certain quantities of a specific crop
   Cooperatives - several producers have joined together to collectively market their products
   Migrant workers - laborers who travel from farm to farm during the growing and harvesting season

J. Answers to AS 12.1

1. Enzymatic browning occurs when plant tissue is exposed in a brown colored pigment, melanin, being produced as a result of a series of biochemical reactions.

2. Warm temperatures and plenty of air exposure enhance the browning process. An enzyme called polyphenol oxidase acts as a catalyst to speed up the process which can occur rapidly at warm temperatures when the pH is between 5.0 and 7.0.

3. Acids such as ascorbic acid and citric acid are commonly used in the food industry.

4. Citric acid acts as a delating agent to prevent the fruit from browning. Citric acid inhibits the polyphenol oxidase enzyme by reducing copper ions which are necessary for the enzyme to be active.

UNIT II - FOOD PROCESSING Name ______________________________

Lesson 12: Processing Fruits, Vegetables, and Nuts Date ______________________________

EVALUATION

Match the processing technique on the left with the descriptions on the right.

___ 1. Treating with ethylene gas

___ 2. Blanching

___ 3. Adding sodium bisulfite

___ 4. Canning

a. Prevents enzymatic browning

b. Inactivation of enzymes by heating

c. Blanching, peeling, can filling, air removal, sealing, retorting

d. Washing and polishing

e. Used in ripening chambers

f. Heated, oiled, salted, oiled

Complete the following short answer questions.

5. Rank the following in the order of their nutrient quality. Begin by placing a "1" by the item with the most nutrients.

_____ dried fruit

_____ fresh fruit

_____ canned fruit

6. The fruit, vegetable, and nut industries are characterized by contract production, cooperatives, and migrant workers. Explain what these three terms mean.

Name ________________

Enzymatic Browning

Objective: The student will investigate the process of browning in fruits and test the effects of various substances in preventing browning.

Activity Length: 1 hour

Materials and Equipment:

Fresh fruit or vegetable (apples, bananas, peaches, pears, avocados will work well)
Vinegar - acetic acid
Lemon juice - citric acid
Fruit Fresh®
Beakers or wide-mouth jars
Tongs
Paper towels
Water

Procedures:

1. Prepare 200 ml of each of the following solutions and place them in 4 separate jars.

   fruit fresh
   lemon juice
   vinegar
   water

2. Cut the pieces of fresh fruit or vegetables into six pieces of approximately equal size.

3. Using tongs, dip a separate piece of the sample fruit into each of the three acid solutions and water and place the samples on a paper towel. Rinse the tongs after each use.

4. Put an untreated piece of the sample on the paper towel.

5. Record on the 0 min line what each piece looks like as soon as they are all placed on the towel. For texture, look at the fruit but do not touch. Touching the surface of the fruit adds bacteria from your hands.

6. Observe all 5 samples every ten minutes for the class period. Record your observations.

Time	Record Observations														
	Fruit Fresh			Lemon Juice			Vinegar			Water			Air		
	Color*	Odor	Texture	Color*	Odor	Texture	Color*	Odor	Texture	Color*	Odor	Texture	Color*	Odor	Texture
0 min															
10 min															
20 min															
30 min															
40 min															
50 min															

*Color Code

5 completely dark brown
4 fully covered light brown
3 half covered light brown
2 slight or scant brown patches
1 no browning present

Questions

1. What causes browning when fresh fruits and some vegetables are peeled or cut?

2. What conditions enhance the browning process? Why?

3. How do food additives or treatment processes in use today prevent or retard browning in fruits and vegetables.

4. Why do citrus juices retard browning in fresh fruits?

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 1: Factors That Affect Food Safety and Quality

Objective: The student will be able to identify the factors that affect food safety and quality.

Study Questions

1. **What factors contribute to food spoilage?**
2. **How do contaminants influence food safety?**
3. **What production factors assure food safety and quality?**
4. **How do food additives influence food safety and quality?**
5. **How is food safety monitored?**
6. **How do consumers assess the risk associated with food safety?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.
2. Activity Sheets

a)	AS 1.1	Nitrates in Meat
b)	AS 1.2	Food Safety Issues
c)	AS 1.3	Food Safety Concerns Survey

Lesson 1: Factors That Affect Food Safety and Quality

TEACHING PROCEDURES

A. Introduction

Define biochemistry in relation to food science. Biochemistry is the scientific study of the chemical properties of living matter, in this case food.

B. Motivation

1. Show the video, The Nature of Change, and discuss BST: The Facts, which are available from:

   Monsanto Publication
   800 N. Lindbergh Blvd
   St. Louis, MO 63167
   (314) 694 - 1000

2. Brainstorm with students to get their ideas on where biotechnology in food science might be going. One example is the fast-paced development of seedless watermelons.

   Dennis J. Gray and Gary W. Elmstrom, of the University of Florida, have developed a tissue culture process that clones thousands of seedless watermelon plants in just months instead of years. Seedless watermelons could gain a large market share if their reproductive efficiency can be heightened.

   Seedless watermelons do produce a small number of seeds, but only enough to postpone the complete development of a new cultivar for 10-15 years. A parent line with two copies of each chromosome in each cell is crossed with another parent line consisting of four copies of each chromosome/cell. The offspring is seedless because only three copies of each chromosome are present in each cell.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss with students the factors that contribute to food spoilage.

   What factors contribute to food spoilage?

   a) Microorganisms
   b) Natural enzymes
   c) Insects, parasites, and rodents
   d) Temperature
   e) Moisture/dryness
   f) Air - oxygen
   g) Light
   h) Time

2. Discuss how contaminants influence food safety.

How do contaminants influence food safety?

a) Microorganisms ferment sugars; hydrolyze starches and fats; digest proteins; form acids, pigments and discolorations. These lead to rancid flavors, putrid odors, gas and foam production, and poisonous toxin production.
b) Enzymes catalyze reactions that lead to microbial invasion, rancid flavors, and browning.
c) Insect spoilage leads to microbial invasion; parasites inhabit the consumer; rodents spread diseases, and fecal material.
d) Natural dehydrating causes skin breakage which allows bacterial invasion. Freezing causes cell swelling, which causes the cell membrane to rupture.
e) Temperature, moisture, air, light, and time can lead to microbial invasion.

3. Discuss what production factors assure food safety.

What production factors assure food safety and quality?

a) Quality Assurance Programs - document production and food processing practices
b) Proper control of temperature and humidity
c) Use of pesticides
d) Use of animal drugs
    1) Follow withdrawal guidelines to avoid residues
    2) Proper injection procedures
    3) Proper handling of animals
e) Grain producers - grade standards regulate grain quality

4. Discuss how food additives influence food safety. Food additives are to improve a food's appearance, flavor, texture, nutritional value or storage properties. The Food Additives Amendment of 1958 covers both intentional and incidental additives. See the student reference for definitions and examples of the food additives. Have students complete AS 1.1.

How do food additives influence food safety and quality?

a) Preservatives
b) Antioxidants
c) Stabilizers/thickeners
d) Sequestrants
e) Nutrient supplements
f) Surface active ingredients
g) Bleaching and maturing agents
h) Buffers, acids, alkalies
i) Nitrates/nitrites
j) Food colors
k) Non-nutritive and special dietary sweeteners
l) Flavoring agents
m) Miscellaneous

5. Discuss how food safety is monitored.

How is food safety monitored?

a) USDA's Food Safety and Inspection Service - inspectors

b) FDA inspects processing plants
c) Local, county, and state health departments

6. Discuss how consumers assess the risk associated with food safety. Have students complete AS 1.2 and AS 1.3. Discuss their answers to AS 1.3.

   How do consumers assess the risk associated with food safety?

   a) Common sense/rational thinking
   b) Irrational/fearful

F. Other activities

1. Have students survey their parents' concern about food safety. Have them complete AS 1.3. See how the parents' concerns compared to the class.

2. Have students prepare a paper from topics provided by the instructor. The paper should include: a summary of the facts; their personal views and the views of a classmate; and a journal article supporting their position.

3. Have students complete an activity from The Chemistry of Food Additives by Flinn Scientific, P.O. Box 29, Batavia, IL 60510, (708) 879-6900.

G. Conclusion

Various factors contribute to food spoilage. Microbes digest food and leave behind unpleasant reminders. Proper quality-assured handling can greatly promote food safety. Food quality is regulated by local, state, and federal authorities.

H. Competency

Identify the factors that affect food safety and quality.

Related Missouri Core Competencies and Key Skills:

9D-5: Describe the relationships between technologies which improve our lives and the environmental problems that can result from them.
10L-5: Identify the pros and cons of an environmental issue, take a position, and support.

I. Answers to Evaluation

1. Four of the following: microorganisms; natural enzymes; insects, parasites, rodents; temperature; moisture/dryness; air - oxygen; light; time

2. a
3. c
4. a, c
5. a
6. b
7. a

8. Two of the following:
   a. Follow withdrawal guidelines - leave no residues
   b. Proper injection procedures - do not damage tissue

c. Proper handling - avoid bruising
d. Honesty - consistent quality of entire truck with grain sample

9. d
10. c
11. f
12. a
13. l
14. h
15. c
16. d
17. e
18. k
19. g
20. j
21. b
22. i

J. Answers to Activity Sheets

AS 1.1

1. The sample with nitrite added is the one that looks more like ham since this is the treatment ham gets.

2. Students will choose the sample containing nitrate. The color alone does not justify the addition of nitrite since it also affects the taste (flavor). Without it, the ham would taste like a salty pork roast. Nitrites also act as powerful antioxidants. Nitrates also inhibit the growth of *clostridium botulinum* that causes botulism. This is an excellent opportunity to discuss the risk benefit of food additives.

3. Answer will vary.

The changes of color illustrate the reactions explained in the chart. Since the meat was not totally processed and the possible microorganisms are still present in the sample, meat should be disposed of and not consumed. One needs to know that nitrite in large concentrations is toxic, therefore, potentially dangerous.

The meat utilized in the experiment will be in the oxymyoglobin although the surface may be brown (metmyglobin). The addition of nitrate to one portion will form the dark red nitrosomyoglobin after 24 hours in the refrigerator.

Heating the nitrosomyoglobin will form the more stable nitrosohemochrome (light pink). In the untreated sample, oxymyoglobin (bright red) will be in the interior, and on the surface. A gray brown denatured myoglobin (brown) in the control sample will result after heating. This is the characteristic color of uncured, cooked meat.

AS 1.2 Instructor's discretion.

AS 1.3 Discuss student's responses. According to the United States Food and Drug Administration (FDA) the ranking for most important food safety considerations is as follows:

_1_ Disease--causing microorganisms

_3_ Environmental contaminants (lead poisoning for example)

_6_ Food additives

_4_ Naturally occurring toxins (poisonous plants for example)

_5_ Pesticide residue

_2_ Poor nutrition

UNIT III - THE BIOCHEMISTRY OF FOODS Name ______________________________

Lesson 1: Factors That Affect Food Safety and Quality Date ______________________________

EVALUATION

Match the spoilage with the agent that caused it.

1. ____ Ferment sugars
2. ____ Enzymatic browning
3. ____ Cause rancidity
4. ____ Hydrolyze starch and fats
5. ____ Spread disease
6. ____ Cause microbial invasion

a. Microbes
b. Insects, parasites, rodents
c. Enzymes

Complete the following short answer questions.

7. Name four factors that contribute to food spoilage.

8. Name two production procedures and how they ensure food safety.

Circle the letter that corresponds to the best answer.

9. Who monitors food safety?

   a. USDA only
   b. FDA only
   c. USDA and county and state inspectors
   d. USDA, FDA, and local, county, and state inspectors

10. Risk assessment should be based on:

   a Emotions
   b. Only the media
   c. Common sense
   d. Traditions

Match the type of food additive on the right with the best description on the left.

11. ____ Emulsify oil-in-water and water-in-oil mixtures, ex., lecithin

12. ____ Extend shelf life and prevent deterioration, ex., sodium benzoate

13. ____ Low-calorie sweeteners, dietetic and diabetic foods

14. ____ Modify pH

15. ____ Chelate trace metals, prevent oxidation and off-coloring, ex., EDTA

16. ____ Thickeners, ex., pectin

17. ____ Whiten flour and milk

18. ____ Contribute to pink color in meat

19. ____ Added to foods deficient in necessary nutrients

20. ____ Spices, herbs, extracts

21. ____ Prevent breakdown of vitamins and lipids, ex., BHA

22. ____ Caramel, extract of annatto, natural grape red

a. Preservatives

b. Antioxidants

c. Sequestrants

d. Stabilizers

e. Bleaching/maturing agents

f. Surface active ingredients

g. Nutrient supplements

h. Buffers, acids, alkalies

i. Food colors

j. Flavoring agents

k. Nitrates/nitrites

l. Non-nutritive additives

Lesson 1: Factors That Affect Food Safety and Quality Name ________________

Nitrites in Meat

Objective: To observe the differences between fresh red meat with and without sodium nitrate added, and observe the changes after both samples are heated.

Activity Length: Two 50-minutes periods

Background Information: Cured meat is the result of a process whereby the addition of a nitrate salt causes flavor and color changes in fresh meat. The cure also acts as a preservative and inhibits the growth of pathogenic microorganisms. The nitrate salt in this process is always used in conjunction with a least some other additive such as salt, sugar, spices, and/or smoke.

Materials and Equipment:

200 g ground beef
Scale
0.016 g Sodium nitrate
2 Beakers
1 Plastic bag
Wax paper
Refrigerator
Stove or hot plate
Pan for steaming meat
Labels (masking tape will do)
Pen

Procedure:

1. Divide the freshly ground hamburger into two samples of 100 g each.

2. Put one of the samples of hamburger in a plastic bag and add 0.016 g of sodium nitrate. Mix thoroughly by kneading the bag for about 3 minutes. Label beakers A and B.

3. Empty the contents of each bag in a beaker. Pack meat down to get rid of as much air as possible. Cover the beakers with a piece of wax paper. Record which beaker contains nitrate. Also put your name on each beaker.

4. Examine and record both the surface color and the interior color of each sample. Do not taste either sample.

5. Place beakers in a refrigerator overnight.

6. After 24 hours, remove the beakers from the refrigerator and examine the surface and interior of the meat, compare colors.

7. Heat each beaker over a steam bath for 15-20 minutes.

8. Once again, examine the samples as before. Do not taste either sample.

9. Record your results on Table 1.1.

Table 1.1

	Control (no nitrite)		Experimental (with nitrite)	
	Surface	Interior	Surface	Interior
Before Storage				
After Storage				
After Cooking				

Key Questions:

1. Which of the samples, after cooking, most closely resembles sausage?

2. Which of the cooked samples looks the most appetizing?

3. Would you purchase meats processed with nitrates? Explain your answer.

Adapted from: Frick, Marty. *Food Science, Safety and Nutrition.* The National Council for Agricultural Education, 1993.

Name ____________________

Food Safety and Issues

Objective: Examine an issue regarding food safety.

Directions: Select a food safety issue. Research the topic and prepare a report to answer the following questions:

1. Why is this issue important?
2. What effect does this issue have on people?
3. What is the history behind the issue?
4. What are the risks caused by the issue?
5. Is there a definite right and wrong side to the issue?
6. What are possible solutions?
7. What is my opinion of the issue?

Topic Ideas:

•Are hormones given to beef cattle present in the meat eaten by humans?

•Do pesticides affect the quality of food in the U.S.?

•Is organically grown food more nutritious than foods grown with pesticides and fertilizers?

•Does food coloring affect food quality?

Food Safety Concerns Survey

Please rank your greatest food safety concern #1 and your least concern #6, and rank all of the numbers in between in a similar manner. Do not put your name on this paper. The purpose of this exercise is to see how your answers compare with others.

The following food safety concerns are listed in alphabetical order.

___ Disease--causing microorganisms

___ Environmental contaminants (lead poisoning for example)

___ Food additives

___ Naturally occurring toxins (poisonous plants for example)

___ Pesticide residue

___ Poor nutrition

Lesson 2: Problems with Food Deterioration

Objective: The student will be able to describe problems resulting from food deterioration.

Study Questions

1. **What physical changes result from food deterioration?**
2. **What chemical changes result from food deterioration?**
3. **What environmental conditions favor bacterial growth in foods?**
4. **What organisms contribute to food deterioration?**
5. **What are some of the organisms found in food that can cause human diseases?**

Reference

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.

Lesson 2: Problems with Food Deterioration

TEACHING PROCEDURES

A. Review

Review the factors that contribute to food deterioration. They are: microorganisms, natural enzymes, insects, parasites, rodents, temperature, moisture, air, light, and time.

B. Motivation

Imagine you are in the military overseas and it is your birthday. You have anticipated receiving food packages from family back home. You can taste the chocolate chip cookies, caramel popcorn, homemade apple cider and dinner rolls.

Unfortunately, your platoon is involved in field exercises and it will be two weeks before you get back to base. You can only hope the birthday box will still be there when you get back. You are looking forward to the goodies more than ever. Hopefully, the box will be refrigerated until you get back.

The last day of field exercise has passed as you tiredly return to the base. Your hunger pains can only be satisfied with the contents of your birthday box.

To your surprise, the box is resting on your bunk. Unopened, but also unrefrigerated. You can only hope the food has not molded nor grown stale. You quickly cut the strings and dig into the box where you find four packages, individually wrapped in tin foil. In just a few seconds you will satisfy your taste buds. In fact, your mouth is watering.

The first package is chocolate chip cookies, but they are all green with mold. You decide the next package will surely be all right, but the rolls have circular molds on them, and are as hard as hockey pucks. Your disappointment grows deeper as you taste the apple cider's bitter flavor and the caramel corn's staleness. What caused all of this?

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the physical changes from food deterioration.

What physical changes result from food deterioration?

a) Dehydration - excessive heat, cold, or exposure to air
b) Cracked skin - fruit frozen then thawed
c) Broken emulsion - liquid foods frozen then thawed
d) Texture degradation - frozen milk will curdle
e) Off-color (surface)
    1) Fruits and vegetables stored at too low a temperature
    2) Light causes surface discoloration of meat pigments
    3) Insufficient oxygen to cut meat surfaces reduces oxymyoglobin to metmyoglobin (brownish-red color)

    - 4) Mold growth causes a variety of color development
- f) Internal browning - apples stored at too low a temperature
- g) Lumping/caking/crystallization - excessive moisture
- h) Surface pitting - fruit stored at too low a temperature

2. Discuss the chemical changes that result from food deterioration.

   What chemical changes result from food deterioration?

   - a) Sugars ferment
   - b) Starches hydrolyze
   - c) Fats hydrolyze (lipolysis) - causes rancidity
   - d) Proteins are denatured or digested - ammonia-like odors
   - e) Toxin production
   - f) Enzymatic reactions
   - g) Pigment conversion

3. Discuss what environmental conditions favor bacterial growth.

   What environmental conditions favor bacterial growth in foods?

   - a) Warm temperature; although some bacteria grow at very high or at very low temperatures
     - 1) Psychrophilic - grow in temperatures as low as 32°F
     - 2) Mesophilic - 60°-100°F, most bacteria are this type
     - 3) Thermophilic - grow in temperatures as high as 180°F
   - b) Moist conditions

4. Discuss what organisms contribute to food deterioration.

   What organisms contribute to food deterioration?

   - a) Bacteria
   - b) Fungi - yeasts and molds

5. Discuss what human diseases may be caused by unsafe food.

   What are some of the organisms found in food that can cause human diseases?

   - a) Campylobacteri
   - b) Clostridium botulism
   - c) Escherichia coli (E. coli)
   - d) Hepatitis A Virus
   - e) Listeria
   - f) Salmonella
   - g) Staphylococcus
   - h) Toxoplasma
   - i) Trichinella
   - j) Vibrio parahaemolyticus
   - k) Yersinia

F. Other activities

1. Make kimchee to study lactic acid fermentation. A detailed procedure can be obtained from Bottle Biology Program, University of Wisconsin-Madison, (608) 263-5645.

2. Invite a health department official to present a program on food-borne diseases.

G. Conclusion

Food deterioration is a continual problem for the food industry. Physical and chemical deterioration result from microbial and environmental influences. Unsafe food can thus cause a multitude of human diseases.

H. Competency

Describe problems resulting from food deterioration.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. a
2. b
3. a
4. a
5. b
6. a
7. a
8. b
9. b
10. b

11. Warm temperatures, moisture

12. b
13. a
14. a
15. b
16. b
17. a
18. b
19. d
20. a
21. c
22. e

UNIT III - THE BIOCHEMISTRY OF FOODS

Name ______________________________

Lesson 2: Problems with Food Deterioration

Date ______________________________

EVALUATION

Is the type of deterioration on the left a physical change or chemical change? Write the correct letter in the blank.

1. ____ Dehydration
2. ____ Starches hydrolyze
3. ____ Off-color
4. ____ Internal browning
5. ____ Acid production
6. ____ Surface pitting
7. ____ Lumping, caking
8. ____ Pigment conversion
9. ____ Lipolysis
10. ____ Toxin production

a. Physical change

b. Chemical change

11. List the 2 environmental conditions needed for most microbes to grow.

Match the microbial characteristic on the left with the appropriate type of microbe on the right.

12. ____ Used to ripen certain types of cheese
13. ____ Unicellular
14. ____ Procaryote
15. ____ Grow by mycelia
16. ____ Require oxygen
17. ____ Classified based on shape

a. Bacteria

b. Fungi (molds, yeasts)

Match the disease on the right with the description on the left.

18. ____ Transmitted by improperly processed or unrefrigerated low acid foods

19. ____ Leading cause of gastroenteritis in humans

20. ____ Caused by salmonella bacteria

21. ____ Raw pork from hogs fed uncooked garbage

22. ____ Meat animals can be infected by cats, which are a common host of this disease

a. Salmonellosis

b. Botulism

c. Trichinosis

d. Camphyolbacteriosis

e. Toxoplasmosis

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 3: Nutritional Properties of Foods

Objective: The student will be able to describe the nutritional properties of foods.

Study Questions

1. **What are the major food groups?**
2. **What are the six classes of nutrients?**
3. **What are the nutritional characteristics of each food group?**
4. **What are the functions for each nutrient class?**
5. **What are the sources for each nutrient class?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.
2. Activity Sheet
   a) AS 3.1: Identify Basic Food Nutrients

Lesson 3: Nutritional Properties of Foods

TEACHING PROCEDURES

A. Review

The previous lesson discussed the physical and chemical changes from food deterioration and food-borne diseases and their causes. This lesson takes a look at the nutritional properties of food, including diseases caused by a nutrient deficiency.

B. Motivation

Bring a baked potato and french fries to class. Poll the class on their preferences, then compare french fries to a baked potato. Analyze nutritional data using the table below.

Nutrition of French Fries versus Baked Potato

				% Daily Values				
	Grams	#Calories Food Energy	Calories from fat	Protein	Vit. A	Vit. C	Calcium	Iron
French Fries	70	220	100	3	0	10	2	2
Baked Potato	70	80	1	2	0	15	0	6

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the major food groups. Use the new Food Pyramid. Discuss where fats and sweets fit into the Food Pyramid.

   What are the major food groups?

   a) Meats
   b) Breads & cereals
   c) Fruits
   d) Vegetables
   e) Dairy products

2. Discuss the six classes of nutrients.

   What are the six classes of nutrients?

   a) Carbohydrates

- b) Proteins
- c) Fats
- d) Vitamins
- e) Minerals
- f) Water

3. Discuss the nutritional characteristics of each food group.

What are the nutritional characteristics of each food group?

- a) Meats - protein primarily, also carbohydrates, fats, vitamins, and minerals
- b) Breads and cereals - carbohydrates primarily, also protein, fat, vitamins, and minerals
- c) Fruits - vitamins and minerals, also protein and carbohydrates
- d) Vegetables - minerals and vitamins primarily, also protein, and carbohydrates
- e) Dairy foods - excellent source for all five nutrient categories

4. Discuss the functions of each nutrient class.

What are the functions for each nutrient class?

- a) Carbohydrates - 4 Calories per gram of energy; 98 percent are digested and completely oxidized
  - 1) Needed for body heat
  - 2) Synthesis of tissue
  - 3) Energy to work and play
  - 4) Increase fat utilization efficiency
  - 5) Spare proteins from being converted to a major energy source
  - 6) Provide fiber
  - 7) Promote vitamin B synthesis
- b) Proteins - 4 Calories per gram of energy; 70 percent are digested and completely oxidized
  - 1) Primary role is to supply nitrogen-based molecules necessary for tissue synthesis and provide essential amino acids
  - 2) Source of essential amino acids: leucine, isoleucine, lysine, methionine, phenylerlanine, threonine, tryptophan, valine plus histidine for childhood growth
  - 3) Secondary role is to supply energy
- c) Fats - 9 Calories per gram of energy; 95 percent are digested and completely oxidized
  - 1) Supply necessary polyunsaturated fatty acids
  - 2) Aid in absorption of fat-soluble vitamins A, D, E, and K
  - 3) Source of phospholipids
  - 4) Insulate and protect body
  - 5) Reserve source of energy
- d) Vitamins - needed for enzyme systems which are required for protein, fat, and carbohydrate metabolism, needed in relatively small amounts except vitamin D.
  - 1) Vitamin A - needed to prevent: night blindness, abnormal bone and tooth development, diseases of skin, fat-soluble
  - 2) Vitamin D - increase Ca & P absorption, reduces bone defects, fat-soluble
  - 3) Vitamin E - favors Fe absorption; antioxidant, fat-soluble
  - 4) Vitamin K - essential for normal blood clotting, fat-soluble
  - 5) Vitamin C - prevents scurvy, bone joint disease, teeth loosening, and fragile capillary walls; needed for normal protein collagen formation, water-soluble
  - 6) Vitamin B complex - water-soluble
    - (a) B_1 (thiamine) - needed to oxidize glucose
    - (b) B_2 (riboflavin) - needed for cellular growth and tissue maintenance

(c) Niacin - needed for tissue respiration and glucose oxidation
(d) B_6 - needed for enzyme systems
(e) Pantothenic acid - needed for mental health
(f) B_{12} - needed for nucleic acid formation; helps prevent anemia
(g) Folacin - helps prevent anemia; used for nucleic acid production
(h) Biotin - helps metabolize fatty acids & amino acids

e) Minerals - needed in relatively small amounts.
1) Ca - needed for blood clotting, bone & tooth development, enzyme function; control of fluid through membranes
2) P - needed for metabolism, controls acid-alkaline reactions in blood, phospholipid production
3) Mg - needed for enzyme systems, electrical potential in nerves; muscle contraction, Ca & P metabolism
4) Fe - needed for blood hemoglobin & muscle myoglobin
5) Cu - helps utilize Fe & synthesis of hemoglobin
6) Co - part of vitamin B_{12}
7) Zn - needed for enzyme production
8) Na - needed for osmotic equilibrium and body fluid volume
9) Cl - exists in chloride form; helps produce hydrochloric acid
10) K - helps regulate osmotic pressure, equilibrium, and pH; enzyme production
11) I - needed for thyroid hormone
12) F - needed for sound teeth
13) Mn - bone structure, central nervous system function, reproduction
14) Cr - glucose metabolism
15) Mo - protein metabolism

f) Water - 60 percent of body weight
1) Solvent for chemical reactions in body
2) Transport media to cells
3) Removes body waste
4) Regulates body temperature and metabolism rate

5. Discuss the sources for each nutrient. Point out that each nutrient comes from other sources as well. Divide class into small groups to complete AS 3.1. The instructor should demonstrate the tests before students complete the activities.

What are the sources for each nutrient class?

a) Carbohydrates - potatoes, rice, flour, dairy products
b) Proteins - meat, poultry, fish, eggs, dairy products, legumes
c) Fats - meat, poultry, grain oils, nuts, dairy products
d) Vitamins - fruits, vegetables, dairy products
e) Minerals - meat, fruits, vegetables, dairy products
f) Water - beverages, high water-content foods

F. Other activities

1. Assign each student to plan a complete meal. This meal must contain 2 servings of breads/cereals, 1 serving of fruits, 1 serving of vegetables, 1 serving of meat, 1 serving of dairy products, and 1 serving of a beverage. They are to research what nutrition is provided per serving and then complete the following chart.

% Daily Value Nutrition/Serving	Breads/Cereals	Meats	Fruits	Vegetables	Dairy Products	Beverage
Protein						
Vitamin A						
Vitamin C						
Calcium						
Dietary Fiber						
Fat						
Iron						
Sodium						
# Servings	2	1	1	1	1	1
Total % Achieved						

2. Assign oral reports on: Iron in diet, zinc in diet, types of iron, types of cholesterol, fiber value in diet, calcium in diet, vegetarian diet, nutrient density.

   For information on Activity 2, write: National Live Stock and Meat Board, 444 North Michigan Ave., Chicago, IL 60611. Ask for: Percent U.S. R.D.A. Chart Exploring Meat and Heath, Zinc, Iron

3. Students are to select a balanced meal from items on the menu at a local McDonald's. Students can only spend $5.00. Students will need to get nutrient information from local McDonald's restaurants.

G. Conclusion

Foods are divided into meats, breads/cereals, fruits, vegetables, and dairy products. These food groups supply carbohydrates, proteins, fats, vitamins, and minerals. Water is also a necessary nutrient. A healthy diet consists of items from all food groups.

H. Competency

Describe the nutritional properties of foods

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. a
2. b
3. d
4. e
5. a
6. b
7. e
8. c
9. f
10. f
11. e
12. c
13. b
14. b
15. c
16. c
17. b
18. d
19. a
20. Teacher's discretion

J. Answers to Activity Sheets

AS 3.1

1. Answers will depend on types of food tested. Answers for foods listed in materials list follow:

   a) raw potato, rice kernels, croutons, milk
   b) sucrose, honey, jam
   c) cheese, milk, chicken, beef or pork, bacon, hamburger, dry beans, egg white
   d) cheese, whole milk, egg white, bacon, hamburger, mayonnaise, butter, margarine
   e) potato, rice, cheese, croutons, milk, meat, beans
   f) orange

2. Answers will vary.

3. By determining the nutrients (components) in various foods, we can become more aware of how well we are feeding our bodies.

UNIT III - THE BIOCHEMISTRY OF FOODS

Name ____________________

Lesson 3: Nutritional Properties of Foods

Date ____________________

EVALUATION

Match the nutrient class on the right with its role on the left.

____ 1. Supply the majority of your energy

____ 2. Protein synthesis

____ 3. Regulates body temperature

____ 4. Provide fatty acids

____ 5. Major source of fiber

____ 6. Source of nitrogen

____ 7. Insulate body

____ 8. Prevent scurvy; night blindness

____ 9. Major source for blood hemoglobin, bone development, osmotic equilibria

a. Carbohydrates
b. Proteins
c. Vitamins
d. Water
e. Fats
f. Minerals

Match the nutrient class on the right with the examples on the left.

____ 10. Ca, P, K, Mg, Zn, Fe

____ 11. Riboflavin

____ 12. A, B complex, C, D, E, K

____ 13. Lysine

____ 14. Threonine

____ 15. Thiamine, niacin, folacin

a. Carbohydrates
b. Proteins
c. Vitamins
d. Water
e. Fats
f. Minerals

Circle the letter that corresponds to the best answer.

16. Which nutrient is the most energy rich compound?

    a. Proteins
    b. Vitamins
    c. Fats
    d. Minerals

17. Which nutrient class is divided into fat-soluble and water-soluble?

a. Proteins
b. Vitamins
c. Fats
d. Minerals

18. Which nutrient class makes 60 percent of the human body's weight?

a. Carbohydrates
b. Proteins
c. Minerals
d. Water

19. Which nutrient class is 98 percent digested and utilized in the body?

a. Carbohydrates
b. Proteins
c. Minerals
d. Water

20. List two reliable sources for each of the six nutrient classes.

Lesson 3: Nutritional Properties of Foods

Name ________________

Identifying Basic Food Nutrients

Objective: To determine the presence of complex carbohydrates, simple carbohydrates, protein, fat, minerals, and vitamin C in common foods.

Activity Length: 2 days

Materials and Equipment (for each group):

Lab apron (1 per student)
Safety glasses (1 per student)
15 foods divided into 6 small amounts (suggestions below)
    ½ small raw potato
    60-90 rice kernels
    1-inch cube cheese
    6 croutons
    1 tablespoon sucrose (table sugar)
    1 tablespoon honey
    1 tablespoon whole or skim milk
    1 tablespoon jam or jelly
    1 tablespoon cooked chicken (no skin), beef or pork
    1 cooked egg yoke or white (note which)
    1 small leaf of lettuce
    1 tablespoon raw bacon or hamburger
    1 tablespoon mayonnaise
    ¼ orange or 2 tablespoons orange juice
    1 tablespoon butter or margarine
    Pulverized dry beans or any pulverized food
    1 tablespoon water
Lugol's iodine with dropper
Biuret solution
Benedict's solution
Source of gas flame
Eyedropper
Paring knife
Cutting board
Heavy duty aluminum foil
Brown paper
Paper cups
2 small paper plates
Tongs or tweezers
Graduated cylinder
100-ml beakers
Stirring rod
Pipette
Test tubes
Test tube holder
Distilled water
Cornstarch

Aluminum foil pie tin or shaped foil container

Procedure:

1. Since you will be working in small groups for this activity, read the instructions for each experiment and determine who will assume responsibility for each part.

2. Assemble foods (only small amounts are needed) to be tested on small paper plates and label as needed.

3. Carefully follow instructions for each test.

4. Record observations for each experiment.

5. Analyze data, determine conclusion, and complete laboratory report.

CAUTION: Do not eat any of the foods being tested.

TEST #1 for COMPLEX CARBOHYDRATE (starch)

1. Supplies:

Aluminum foil
Eyedropper
Lugol's iodine
Foods to test

2. Procedure:

   a. Cut the aluminum foil into squares 4 cm on each side (one square for each food type). Place the 4-cm squares of aluminum foil on the table, and place a small amount of each food sample on a square.

   b. In the data table indicate the test results you expect for each food in this test.

   c. With an eyedropper, add one drop of iodine test solution onto each sample. A blue-black color indicates the presence of a complex carbohydrate.

CAUTION: Handle iodine very carefully, it stains if dropped on skin, clothes, or surfaces.

   d. Record results for the test as positive (turns blue-black) or negative in the data table.

TEST #2 for SIMPLE CARBOHYDRATE (sugar)

1. Supplies:

Safety glasses
A rack test tube holder
1 test tube for each food to be tested
1 oz. Benedict's Solution for each test tube
Foods to test

2. Procedure:

a. PUT ON YOUR SAFETY GLASSES.

b. Place a small amount of a food in separate test tubes and label each with the name of the food.

c. In the data table, indicate the test results you expect for each of the foods in this test.

d. Add 1 oz. Benedict's Solution to each test tube and heat in a water bath. If solution changes from blue to red-orange, a simple carbohydrate is present.

e. Record results as positive (turns red-orange) or negative in the data table.

TEST #3 for PROTEIN

1. Supplies:

Safety Glasses
Tongs or tweezers
15 100-ml beakers
Distilled water
Stirring rod
Pipette
Test tubes
Biuret solution
Foods to test

2. Procedure:

a. PUT ON YOUR SAFETY GLASSES.

b. Using tongs, put a piece of each food into separate 100-ml beakers and label. (Some foods might need to be ground or chopped before being added to the beaker.)

c. Add enough distilled water to each beaker to just cover the pieces of food. Mix with a clean stirring rod until food is thoroughly moistened.

d. Allow the solutions to stand for at least three (3) minutes.

e. In the data table, indicate the test results you expect for each food for this test.

f. Pipette 1 ml of each food solution into a test tube. Add five (5) drops of Biuret solution to each tube. The appearance of a pink or violet color will indicate the presence of protein (amino acids).

CAUTION: Do not handle the bottle containing Biuret solution. Only touch the rubber bulb of the eyedropper. Biuret can burn your skin and eyes.

g. Record results of the test for protein as positive (turns pink or violet) or negative in the data table.

TEST #4 for FAT

1. Supplies:

4-cm squares of brown paper
Foods to test

2. Procedure:

   a. Cut the brown paper into squares 4 cm on each side (1 square for each food.) Lay the pieces of paper on the table.

   b. In the data table, indicate the test you expect for each food for this test.

   c. Place and rub a small amount of each food on a square and label.

   d. Remove food from square and discard.

   e. After 10 minutes, examine each square by holding it up to a light source. A grease spot will indicate the presence of fat.

   f. Record results for the test for fat as positive (grease spot appears) or negative in the data table.

TEST #5 for MINERALS

1. Supplies:

Aluminum foil pie tin or shaped foil container
Tweezers
Foods to test

2. Procedure:

   a. Place a small amount of one food on the tin or shaped container.

   b. In the data table, indicate the test result you expect from the test.

   c. Heat the food on the tin over a gas flame until burned. If gray powdery ash remains, minerals are present. (Minerals do not burn.)

CAUTION: Tin will become hot, handle carefully.

   d. Repeat steps a-c for the other foods.

   e. Record results for the test as positive (gray powdery ash remains) or negative in the data table.

TEST #6 for VITAMIN C

1. Supplies:

2 cups water and
2 tablespoons cornstarch boiled together for 3 minutes and cooled (this may be done in advance by teacher)
Paper cups
Iodine with dropper
Foods to test

2. Procedure:

a. Chop or grate a small amount of one of the foods into a clean paper cup.

b. In the data table, indicate the test result you expect from this test.

c. Place 1 teaspoon of cornstarch mixture into the same cut. Add 1 drop iodine at a time, swirling to mix between each addition. If the solution turns clear, vitamin C is present. The more drops of iodine needed to clear the solution, the less vitamin C there is in the food.

d. Record results for the test as positive (solution turns clear) or negative in data table.

e. Repeat steps a, b, c, and d for other foods to be tested.

Food	Test for Complex Carbohydrate (+/-)		Test for Simple Carbohydrate (+/-)		Test for Protein (+/-)		Test for Fat (+/-)		Test for Minerals (+/-)		Test for Vit. C (+/-)	
	Pred	Result	Pred	Result	Pred	Result	Pred	Result	Pred	Result	Pred	Result

Key Questions:

1. Based on your tests and observations, which foods are sources of the following nutrients:
    a. Complex carbohydrates
    b. Simple carbohydrates
    c. Protein
    d. Fat
    e. Minerals
    f. Vitamin C
2. How accurate were your predictions compared to your tests?
3. How can you apply the things you learned in this lab to your own eating habits?

Adapted from: Frick, Marty. *Food Science, Safety and Nutrition.* The National Council for Agricultural Education, 1993.

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 4: Processing Influences Nutritional Value

Objective: The student will be able to describe how processing techniques influence the nutritional value of food.

Study Questions

1. **How does temperature affect nutrient availability in foods?**
2. **How does light affect nutrient availability in foods?**
3. **How does water content affect nutrient availability in foods?**
4. **How does oxidation affect nutrient availability in foods?**
5. **What process can be used to maintain or enhance the nutritional value of foods?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.
2. Activity Sheet
    a) AS 4.1: How Processing Affects Vitamin C

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 4: Processing Influences Nutritional Value

TEACHING PROCEDURES

A. Review

Review the six classes of nutrients and their functions in the human body.

B. Motivation

Compare nutritional values of fresh (posted at the grocery store), frozen (on the container), and canned (on the container) fruits and vegetables. Check the list of ingredients to see if Vitamin C (Ascorbic Acid) was added.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss how temperature affects nutrient availability in foods.

   How does temperature affect nutrient availability in foods?

   a) Room or elevated temperatures allow enzymes to degrade tissue and break down vitamins.
   b) Blanching stops enzyme activity.
   c) Proteins toughen when exposed to high cooking temperatures.
   d) High cooking temperatures and long cooking times destroy vitamins.

2. Discuss how light affects nutrient availability.

   How does light affect nutrient availability in foods?

   a) Fluorescent and ultraviolet light can destroy riboflavin.
   b) Vitamins, in general, break down in the presence of light.

3. Discuss how water content affects nutrient availability in foods.

   How does water content affect nutrient availability in foods?

   a) Water-soluble vitamins are a part of a food's juice and are easily lost.

4. Discuss how oxidation affects nutrient availability. Oxidation is the breakdown of nutrients in the presence of oxygen. BHA and BHT are antioxidants.

   How does oxidation affect nutrient availability in foods?

   a) Overcooked or burned foods have been partially oxidized to carbon and oxygen gas and are not useful to the body.
   b) Protein molecules release their nitrogen as nitrous oxide.

5. Discuss what processes are used to enhance the nutritional value of foods.

What processes can be used to maintain or enhance the nutritional value of foods?

a) Enrichment - nutrient levels are increased
b) Fortification - add nutrients that may not have originally been found in foodstuff
c) Supplements - nutrients added to a level in excess of 50 percent RDA
d) Cooking method and length
e) Quick cooling post harvest
f) Waxing/packaging

F. Other activities

1. Have students bring food labels from home that indicate enriched or fortified foods. Compare the labels.

G. Conclusion

Processing does influence the nutritional value of foods. Critical aspects are: temperature, light, water content, and exposure to the air or oxidation. There are several processes that are used to maintain or even enhance a foods nutritional value.

H. Competency

Describe how processing techniques influence the nutritional value of food.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. d
2. d
3. a
4. b
5. b
6. c
7. a

J. Answers to Activity Sheet

AS 4.1

1. Vitamin C is lost when foods are heated.
2. There is a time dependant relationship between heating and Vitamin C destruction.
3. Answers will vary but should indicate that most of the Vitamin C will be lost.

UNIT III - THE BIOCHEMISTRY OF FOODS Name ______________________________

Lesson 4: Processing Influences Nutritional Value Date ______________________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following can cause nutrient loss in foods?

   a. Light
   b. Heat
   c. Boiling in a water bath
   d. All of the above

2. Light, especially fluorescent and ultraviolet, promotes the breakdown of:

   a. Vitamin C
   b. Water
   c. Carbohydrates
   d. Riboflavin

3. Cooking food in a water bath would increase the loss of:

   a. Water-soluble vitamins
   b. Fat-soluble vitamins
   c. Minerals
   d. Proteins

4. Oxidation is defined as:

   a. The binding of protein molecules in the presence of O_2
   b. The chemical reaction in the presence of O_2
   c. The addition of a carbon atom
   d. Inhaling oxygen

Match the word on the right with the definition of the left.

____	5.	Nutrients added to a level that exceeds 50 percent of the RDA	a.	Enrich
			b.	Fortify
____	6.	Nutrient levels returned to levels present before processing	c.	Supplement
____	7.	Nutrients are added to a food that may or may not have been there originally		

Lesson 4: Processing Influences Nutritional Value Name ________________

How Processing Affects Vitamin C

Objective: The student will be able to identify how processing affects Vitamin C retention in vegetables.

Activity Length: One class period

Materials and Equipment:

Blender
Knife
Scale
Cheesecloth or filter paper (a coffee filter will work, but may be a little slow)
Hot plate or stove
Microwave
1 - 200-ml beaker or other heat-resistant container (1 cup Pyrex measuring cup will work in the microwave)
6 - 150-ml beakers (clear disposable plastic drink cups work well)
60 grams of 2 different kinds of fresh vegetables (green beans, broccoli, potato, tomato, etc.)
Water
6 test tubes
Eyedropper
Indolphenol blue dye
Test tube rack
Labels (masking tape will work)
Hotpads

Procedure:

1. Cut the vegetables into uniform pieces, no larger than 3 cm in any dimension.
2. Weigh out 3 portions of each vegetable (total of 6 portions). A portion should weigh about 20 grams.
3. Label the 150-ml beakers with A, B, C (control first vegetable), D, E, and F (control second vegetable).
4. Place 20 grams of one vegetable in beakers A, B, and C.
5. Place 20 grams of the other vegetable in beakers D, E, and F.
6. Add 100 ml water to each beaker.
7. Pour the contents of beaker A into the 200-ml beaker. Heat in the microwave until the water boils. Pour the contents back into beaker A.
   CAUTION: Use hotpads when handling the hot beakers.
8. Wash the 200-ml beaker. Then repeat step 7 with beaker D.
9. Heat beaker B on stove or hot plate for about 30 minutes.
10. Heat beaker E on stove or hot plate for about 30 minutes.
11. Allow beakers to cool.
12. Transfer the contents of beaker A to the blender. Process at high speed until the sample is well blended.
13. Pour the contents of the blender through cheesecloth or filter paper to filter out the liquid. (If you have access to a centrifuge, centrifuge sample for 10-15 minutes.) The sample does not have to be clear. (With some vegetables this step can be eliminated, as long as the sample is liquid enough to pour easily into a test tube.)
14. Measure 60 ml of the filtrate back into beaker A.
15. Rinse the blender thoroughly after filtering the liquid.

16. Repeat Steps 12 -15 for the contents of beakers B, C, D, E, and F.
17. Using the eyedropper, measure 10 drops of indophenol blue dye into 6 test tubes. Label test tubes A, B, C, D, E, and F. Clean eyedropper.
18. Using the eyedropper, carefully add contents of beaker A into test tube A one drop at a time, counting the number of drops needed to make the blue color disappear. Stop adding drops when the color disappears. Record the number of drops added to the test tube.
19. Clean eyedropper before moving to next beaker.
20. Repeat steps 18 and 19, using beaker B with test tube B, so on, with beakers C, D, E, and F.
21. Vitamin C bleaches the blue color out of indophenol blue. This lab will make qualitative distinctions between the different processing techniques based on the amount of vitamin C they possess. The fewer the number of drops needed to make the blue color disappear, the greater the percentage of vitamin C in that sample. If the blue color does not disappear, the beverage is said to contain no vitamin C.

Key Questions:

1. What is the effect of heating on the vitamin C content of vegetables?

2. Why is there a difference between the microwaved vegetables and the vegetables cooked for 30 minutes on the stove.

3. What would you predict would happen if the vegetables were roasted at 350 F for 3 hours (like being cooked in a pot roast)?

Variations:

All kinds of processing treatments could be evaluated using this procedure. For example:

What is the effect of peeling on vitamin C levels?
What about adding salt or vinegar to the liquid?
Freeze the vegetables
Store vegetables for a week at different temperatures

This procedure would also work using fruits, but the amount of material titrated in step seven may have to be adjusted (vitamin C levels in fresh fruit is much higher than in processed juices.)

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 5: Biotechnology in the Food Industry

Objective: The student will be able to describe the role of biotechnology in the food industry.

Study Questions

1. **What is biotechnology?**
2. **How has biotechnology affected food production?**
3. **What are examples of bioengineered foods?**
4. **What business enterprises are involved in biotechnology research?**
5. **How will biotechnology influence the food industry in the future?**
6. **What factors influence new developments in food biotechnology?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit III.
2. Activity Sheet
    a) AS 5.1: A Bioengineered Food Product

UNIT III - THE BIOCHEMISTRY OF FOODS

Lesson 5: Biotechnology in the Food Industry

TEACHING PROCEDURES

A. Review

In Unit 2, Lesson 2, you studied new food product development. It was stated that new products are developed to enhance the food's convenience and nutritional value. Unit 3, Lesson 1, examined the use of food additives in regard to food safety. Biotechnology in food science encompasses all of these ideas, from bioengineered new food products to bio-designed additives. This lesson looks at biotechnology, specifically in the food industry.

B. Motivation

A package of cheese is a good example of biotechnology in food. The rennet was developed using biotechnology. Begin class with the students writing the many ways technology has worked to produce other products. A visual example would be helpful. Examples - chicken sticks, Miracle Whip®, Cool-Whip®.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss what biotechnology is.

   What is biotechnology?

   a) The use of living organisms to make commercial products
   b) The use of microorganisms, animal cells, plant cells, or components of cells such as enzymes to produce products or carry out processes for human benefit

2. Discuss how biotechnology has affected food production.

   How has biotechnology affected food production?

   a) Greater variety of foods
   b) Increased shelf life/safety of food
   c) Greater efficiency in production of food

3. Discuss examples of bio-engineered foods.

   What are examples of bioengineered foods?

   a) Enzymes
      1) Rennet - naturally found in a calf stomach, can be synthetically produced and immobilized
      2) Lactase - cleaves lactose to glucose and galactose, can be immobilized

b) Low-calorie foods - Non-nutritive sweeteners - aspartame, thaumatin, and monellin are taste active proteins. The genes that code for these proteins may be isolated and transferred to bacteria and produced through fermentation.

c) Waste management - certain yeast strains can produce a grape aroma when they consume whey, a cheese-making by-product. This could be used as a flavor component for the wine and food industries.

d) Biological monitoring - DNA fragments from disease-causing microorganisms have been coded and hybridized to probe for the presence of these organisms in food.

e) Cellulose and collagen casings and co-extruded casings

4. Discuss the types of businesses involved in biotechnology research.

What business enterprises are involved in biotechnology research?

a) USDA
b) Universities
c) Food processing companies
d) Commodity organizations
e) National Live Stock and Meat Board
f) Other food/agricultural related companies

5. Discuss how biotechnology will influence the food industry in the future.

How will biotechnology influence the food industry in the future?

a) A growing population will necessitate a growing food supply on less acres.
b) Greater weed control, less insect damage, enhanced nutritional quality and safety, greater disease resistance, improved genetics
c) Longer shelf life, new vaccines, less dependence on petroleum oil, soy- and corn-based product expansion, biological insect control, resistant varieties, more hydroponic-grown food
d) Round-up resistant corn, non-fixing grasses, soy coatings, natural antifreeze

6. Discuss what factors influence new developments.

What factors influence new developments in food biotechnology?

a) Needs of the people
b) Finances
c) Talent pool of researchers
d) Facilities/equipment
e) Weather
f) Time

F. Other activities

1. Have students complete a report on George Washington Carver's advances with the peanut.

2. Show the video, "The Nature of Change," from Monsanto Company, 800 N. Lindberg Blvd., St. Louis, MO 63167, (314) 694-1000.

3. Read and report on "Of the Earth: Agriculture and the New Biology," from the Monsanto Company, 800 N. Lindberg Blvd, St. Louis, MO 63169, (314) 694-1000.

4. Evaluate a news article on biotechnology.

5. Prepare a tissue culture using the Wisconsin fast plants tissue cultures, available from Carolina Biological Supplies.

G. Conclusion

Biotechnology is changing the production and processing of foods. New foods are routinely being developed like the non-nutritive sweeteners: aspartame, thaumatin, and monellin. Biotechnology is also being used to develop synthetic nonfood products like insulin.

H. Competency

Describe the role of biotechnology in the food industry.

Related Missouri Core Competencies and Key Skills:

9D-5: Describe the relationship between technologies which improve our lives and the environmental problems that can result from them.
10D-1: Describe general ways in which human activities affect environmental quality.

I. Answers to Evaluation

1. a
2. c
3. d

4. The use of microorganisms, animal cells, plant cells, or components of cells to produce products or carry out processes for human benefit.

5. Two of the following: greater variety, increased shelf life/safety, greater efficiency in food production.

6. USDA
   Universities
   Food processing companies
   Commodity organizations
   National Live Stock and Meat Board
   Other food/agricultural related companies

7. Teacher's discretion.

J. Answers to Activity Sheets

AS 5.1

1. Too high or low a temperature will render the enzyme inactive or it will not coagulate the curd. (You may want to allow some groups to form curd using high and low temperatures.)

2.

Function	Enzyme
hydrolysis of starch to glucose	glucoamylase
coagulation of milk for cheese production	rennet
clarification and production of fruit juices	pectinase

UNIT III - THE BIOCHEMISTRY OF FOODS Name ____________________

Lesson 5: Biotechnology in the Food Industry Date ____________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following is a non-nutritive sweetener that has been bioengineered?

   a. Aspartame
   b. Corn syrup
   c. Cane sugar
   d. Beet sugar

2. What enzyme is used during cheese making?

   a. Glucose
   b. Lactose
   c. Rennet
   d. Thaumatin

3. What type of casing has been bioengineered to replace natural casings?

   a. Biocasings
   b. Digestive tract casings
   c. Fatty casings
   d. Cellulose casings

Complete the following short answer questions.

4. Define biotechnology.

5. Name two ways biotechnology has affected food production.

6. What are two business enterprises involved in biotechnology research?

7. Use the terms: biotechnology, herbicide-resistant varieties, shelf life, soy coatings, food safety, increased efficiency, in an essay that discusses biotechnology's future role in food production.

Name ________________

A Bioengineered Food Product

Objective: Process hard curd (the primary step in cheese production) using rennin.

Activity Length: 1 class period

Background Information: Chymosin, also known as rennin, is an enzyme that is used in cheese making. When added to milk at the beginning of the cheese-making procedure, it causes the milk to coagulate, or "set," within 30 minutes so that it can be separated into curds and whey. The only source of chymosin for many years was from calf rennet, the extract from stomachs of calves which were slaughtered for veal production. The extract contained, besides chymosin, many impurities. The supply of chymosin also depended on the supply of veal calves (as the cow gets older, its stomach stops producing chymosin). The gene for chymosin has been isolated from cells of calves and inserted into a bacterium. The resultant product, recombinant chymosin, is produced by bacterial cultures in large and controllable quantities. Also, because its production can be highly controlled, it can be easily purified and therefore used without impurities. Chymosin is the first recombinant product to be approved by the FDA for use in food and is now being produced and sold commercially. This procedure demonstrates hard curd production. Hard curds are used in the production of many cheeses, such as, cheddar, Swiss, and Gouda. (Purdue University Cooperative Extension Service, 1992)

Materials and Equipment:

Thermometer
Skim milk - 1 c.
Double boiler
Hot plate
Cups
Plastic spoons and knives
Safety glasses
Rennet solution*
Water

*rennin (rennet solution: crush one junket tablet and dissolve in a tablespoon of water. If material does not dissolve completely, be sure that it is thoroughly dispersed immediately before adding to milk. Junket tablets can be purchased in most grocery stores.)

Procedure:

1. Put on your safety glasses.

2. Place 1 cup of skim milk into the top half of the double boiler.

3. Place water in the bottom of the double boiler on a hot plate. Heat the milk to 95°F-113°F (do not allow the thermometer to rest on the bottom of the pan).

4. With constant stirring, slowly add the rennet solution.

5. Allow the milk to remain at 95-113°F for 15-20 minutes, until a firm gel is formed.

6. Cut the gel into small pieces with a plastic knife.

7. Increase the heat slowly to 113-122°F to firm the curd.

8. Allow the curd to settle.

9. The liquid in the boiler pan is called sweet whey. Pour the sweet whey into a clean cup. Taste when cooled.

10. Examine the curd. Determine the texture/consistency of the curd by squeezing it between your thumb and fingers. You may place a small piece of curd in your mouth and chew it.

Key Questions:

1. What effect does temperature have on this process?

2. What are some major industrial uses of enzymes to produce and process food?

Credit: Frick, Marty. *Food Science, Safety and Nutrition.* The National Council for Agricultural Education, 1993.

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

Lesson 1: Factors that Affect Consumer Choice

Objective: The student will be able to describe the factors that affect consumer choices of food.

Study Questions

1. **What factors affect consumer choice of foods?**
2. **What sensory attributes influence consumer choice?**
3. **How does convenience influence consumer selection?**
4. **How does price affect consumer selection?**
5. **How does packaging affect consumer selection?**
6. **How does shelf life affect consumer choice?**
7. **How do consumer concerns about safety affect food product selection?**
8. **What nutritional concerns affect food product selection?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit IV.
2. Activity Sheet

   AS 1.1: Comparing Snack Foods

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

Lesson 1: Factors that Affect Consumer Choice

TEACHING PROCEDURES

A. Introduction

This unit will look at food science and technology through the eyes of the consumer. Consumer choices, food labels, beverage nutrition, and the link between diet and health will be covered.

B. Motivation

1. Video tape a TV food advertisement. Show it to your class and have them answer the following questions: Is the food healthy? Does it appeal to your emotions? Does it make you hungry/thirsty? What age group does the ad target? Does it list the price?

2. Bring several different pieces of hard candy to class. Have each student select a piece of candy without looking at it. Have students pinch their nostrils closed while they put the candy in their mouths. They should not be able to taste the candy nor should they know what flavor of candy they are eating. Discuss how the senses are dependent on each other. Ask, "Do you eat with your mouth, your nose, or your eyes?" An onion and an apple work well for this activity.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss what factors affect a consumer's choice of foods. Remind the students that everyone is a consumer.

What factors affect consumer choice of foods?

a) Location/supply
b) Cost
c) Time
d) Knowledge/skill
e) Energy
f) Other people
g) Emotions
h) Tools
i) Culture
j) Religion
k) Advertising
l) Lifestyle
m) Values

2. Discuss what sensory attributes influence the consumer's choice.

What sensory attributes influence consumer choice?

- a) Eyesight
    - 1) Color
    - 2) Size/shape
- b) Odor/smell
- c) Sense of taste
    - 1) Sweet
    - 2) Sour
    - 3) Salty
    - 4) Bitter
- d) Feel/touch

3. Discuss how convenience affects consumer selection.

How does convenience influence consumer selection?

- a) Why convenience foods are purchased:
    - 1) Less time required
    - 2) Less energy required
    - 3) Less clean-up needed
    - 4) More variety
    - 5) Less equipment needed
- b) Why convenience foods are not purchased:
    - 1) Desire to prepare their own food
    - 2) More costly to purchase convenience foods
    - 3) More packaging to dispose of

4. Discuss how the price affects consumer selection.

How does the price affect consumer selection?

- a) Smart shoppers are influenced
- b) Impulse buyers are influenced less

5. Discuss how packaging affects consumer selection. Have students complete AS 1.1.

How does packaging affect consumer selection?

- a) Labeling
- b) Environmentally friendly
- c) Size
- d) Cost

6. Discuss how shelf life affects consumer choice.

How does shelf life affect consumer choice?

- a) Longer shelf life is desired
- b) May cost more

7. Discuss how consumer safety concerns affect food selection.

How do consumer concerns about safety affect food product selection?

- a) Many consumers show no concern

b) Others examine food carefully

8. Discuss what nutritional concerns affect food product selection.

What nutritional concerns affect food product selection?

a) Fat content
b) Calories
c) Additives
d) Vitamins and minerals present
e) Fiber
f) Cholesterol

F. Other activities

1. Have students examine at least two newspaper advertisements for food. Compare the products they are advertising, their price, their pictures, the seasonality of the specials, the percentage of food to non-food items, etc.

2. Tour a grocery store and locate the items targeted at impulse buyers.

3. Invite a grocer to speak to the class on how they manage shelf-life on perishable items and what part advertisement plays in sales.

4. Acquire copies of A Guide to the Meat Department from the Beef Industry Council, 444 N. Michigan Ave., Chicago, IL 60611, (312)467-5520. Have students survey the class, their families, or the school using pp. 4-10, 36-40, compare the results to comparable statistics in A guide to the Meat Department.

5. Acquire copies of A Legitimate Beef, Pitman-Moore, Inc. 421 E. Hawley St., Mundelein, IL 60060, (800)541-7459. Have students ask two other people questions, at least one outside of their household. Have questionees write a brief statement on their reactions.

G. Conclusion

Consumers are influenced by a myriad of factors that affect their food selections. Location, time, cost, and religion are a few of these factors. In addition, sensory appeal, convenience, price, packaging, shelf life, safety risk, and nutritional content are all factors that play a major role in consumer selection.

H. Competency

Describe the factors that affect consumer choices of food.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. c
2. b
3. Advantages:
less time required
less energy required
less clean-up

more variety is possible
requires less equipment

Disadvantages:
more costly
consumers desire to prepare their own food
more packaging to dispose of

4. They are making decisions based on emotions, not necessarily intellect.
5. Fat content, calories, additives, vitamins and minerals present, fiber, cholesterol

6. Teacher's discretion

J. Answers to Activity Sheet

AS 1.1 - Teacher's discretion

Name ________________

Date ________________

EVALUATION

Circle the letter that corresponds to the best answer

1. Which of the following is the most economical choice when purchasing for a large family?

    a. Large packages, extended shelf life, low cost, blemished cans
    b. Small packages, short shelf life, high cost, no blemishes
    c. Large packages, average shelf life, low cost, no blemishes
    d. Large packages, short shelf life, high cost, no blemishes

2. A one-person family usually shops for:

    a. Large packages, short shelf life, bright packages, low value
    b. Small packages, long shelf life, fresh to touch, low cost
    c. Small packages, short shelf life, attractive odor, low cost
    d. Large packages, long shelf life, dull package color, high cost

Complete the following short answer questions.

3. Compare/contrast the advantages and disadvantages of convenience foods.

4. Why are impulse buyers less price influenced than shoppers who have planned ahead?

5. List five nutritional concerns consumers exhibit.

6. Use these words in an essay describing a consumer's choice of foods: energy, knowledge/skill, cost, time, location, family size, advertising, religion, values, emotions, tools. (Use the back of this page if necessary.)

Lesson 1: Factors that Affect Consumer Choice

Name ________________

Comparing Snack Foods

Objective: To compare different brands of snack foods

Activity Length: 20 minutes

Materials and Equipment:

*4 different snack foods in individual packages (potato chips, pretzels, banana chips, sunchips, corn chips, etc.)
Bowls
Scale

*If snack foods are not in individual packages, put a serving size for each food into a separate bowl.

Procedure:

1. Record the type of snack food in the top row in the columns under "Types of Snack Foods."
2. Compare the "Nutrition Facts" on the label of each snack food. Record your findings in Table 1.1.
3. Taste each snack food and record your preferences in Table 1.1.

Table 1.1

	Types of Snack Foods			
Serving size				
Weight of product in bag				
Fat				
Saturated Fat				
Calories				
Carbohydrates				
Fiber				
Protein				
Sugar (g)				
Sodium (mg)				
Vitamin C				
Taste preference*				

*(for taste preference, rank 1 thru 4 with 1 being the most preferred.)

Key Questions:

1. Which snack food is the most nutritious? Which do you prefer?

2. Which contains the most salt?

3. Which contains the most fat?

4. Which one did you think tasted the best?

Lesson 2: Interpreting Food Labels

Objective: The student will be able to interpret a food label.

Study Questions

1. **What are the parts of a food label?**
2. **What are the daily dietary requirements for people?**
3. **How does the food label reflect the nutritional content of foods?**
4. **What is the significance of "nutrient content claims" and "health claims"?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit IV.
2. Transparency Master
    a) TM 2.1: Nutrition Labels
3. Activity Sheets
    a) AS 2.1: Nutritional Status
    b) AS 2.2: Identifying Information on a Food Label

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

Lesson 2: Interpreting Food Label

TEACHING PROCEDURES

A. Review

Lesson 1 of Unit IV discussed how sensory attributes of a package can influence consumer choice. This lesson looks specifically at one part of the package, the label. How does the label, its location or its contents, affect consumer selection?

B. Motivation

Bring to class labels from a cereal box, mayonnaise jar, orange juice container, and lunch meat package. Copy all labels so that the product name is covered up. Ask students to guess what these labels came from. Follow with a listing of what information is common for each product.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the parts of a food label.

   What are the parts of a food label?

   a) Principal display panel (PDP)
      1) It must identify the food, either by real name (e.g., green beans) or a made-up name (e.g., Cheerios®).
      2) If picture appears, it must look like the food.
      3) Net contents or net weight must be included.
   b) Information panel (IP)
      1) The IP must include the name and address of the manufacturer.
      2) A list of ingredients must be in order by descending weight.
      3) Nutritional facts panel must be included except in a few instances.

2. Discuss the daily dietary requirements for people. The human body is composed of 60 percent water, 20 percent fat, and 20 percent carbohydrates, proteins, vitamins, and minerals.

   What are the daily dietary requirements for people?

   a) Bread, Cereal, Rice, Pasta Group - 6-11 servings
   b) Fruit Group - 2-4 servings
   c) Vegetable Group - 3-5 servings
   d) Meat, Poultry, Fish, Dry Beans, Eggs, Nuts Group - 2-3 servings
   e) Milk, Yogurt, Cheese Group - 2-3 servings
   f) Fats, Oils, Sweets - use sparingly

3. Discuss how food labels reflect the nutritional content of foods.

   How does the food label reflect the nutritional content of foods?

   a) Total calories
   b) Calories from fat
   c) Total fat - grams and percent daily value
   d) Saturated fat - grams and percent daily value
   e) Cholesterol - grams and percent daily value
   f) Sodium - grams and percent daily value
   g) Total carbohydrate - grams and percent daily value
   h) Dietary fiber - grams and percent daily value
   i) Sugars - grams
   j) Protein - grams
   k) Vitamin A - percent daily value
   l) Vitamin C - percent daily value
   m) Calcium - percent daily value
   n) Iron - percent daily value
   o) Serving size - determined by comparison to a standard serving size; not necessarily the same serving size that is used in the "Food Pyramid"

4. Discuss with students the significance of nutrient content claims and health claims. Point out that before 1990 there were no standards for what the terms meant.

   What is the significance of "nutrient content claims" and "health claims"?

   In 1990 standards were established to define 'nutrient content claims' and 'health claims.'

   a) Nutrient content claims - Words such as "lite," "high," and "low" are clearly defined.
   b) Health claims
      1) phrases that remind consumers that certain nutrients are important
      2) monitored by government scientists
      3) currently only seven different types of claims are allowed

F. Other activities

1. Collect several food labels. Make an answer key for each label based on its identity statement, net contents, and manufacturer's name and address. List on key, the product's ingredients and its nutritional information. Students then select a label and complete AS 2.1.

G. Conclusion

The daily dietary requirements include servings from the groups of bread, fruit, vegetables, meat, and milk. Fats and sweets should be consumed sparingly. While the number of servings may vary, all groups are necessary for a balanced diet. Food labels reflect the nutritional content of foods. Food labels contain the principal display panel and the information panel.

H. Competency

Interpret a food label.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. c
2. d
3. c
4. a
5. b
6. a
7. d
8. e
9. b
10. d
11. a
12. e
13. c

J. Answers to Activity Sheets

AS 2.1 - Instructor's discretion
AS 2.2 - Instructor's discretion

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

Lesson 2: Interpreting Food Labels

Name ____________

Date ____________

EVALUATION

Circle the letter of the best answer.

1. What are the two major parts of the food label?

   a. Ingredients and net weight
   b. Nutrition facts and percent daily value
   c. Principal display panel and information panel
   d. Weight and manufacturer's name

2. The net weight and name of the food appear on what location?

   a. Side panel
   b. Nutritional facts panel
   c. Information panel
   d. Principal display panel

3. On which panel do nutritional facts, ingredients, and name and address of manufacturer appear?

   a. Side panel
   b. Nutritional facts panel
   c. Information panel
   d. Principal display panel

4. What types of information are included on the nutritional facts panel?

   a. Percent daily value and grams
   b. Weight and manufacturer's name
   b. Ingredients and net weight
   c. Ingredients and grams

5. Of the food groups listed, which has the highest number of recommended servings?

   a. Fruit group
   b. Breads, cereal, rice, pasta group
   c. Meat group
   d. Vegetable group

6. Which ingredient is listed first on the food label?

   a. The ingredient that weighs the most
   b. The ingredient with the largest volume
   c. The primary ingredient
   d. The order of the listing of ingredients doesn't matter.

7. The Nutritional Labeling and Education Act of 1990 made changes in the food label. Which of the following statements is not correct?

   a. The types of information included on the nutritional panel was changed.
   b. Terms such as "lite" and "low fat" can only be used if the food product meets certain guidelines.
   c. Guidelines for health claims were defined.
   d. The food label must give the cost of the food product.

Match the group on the left with the correct number of servings on the right. One answer is used twice.

		Food Group		Daily Servings (number of)
____	8.	Dairy group	a.	3-5
____	9.	Bread group	b.	6-11
____	10.	Fruit group	c.	Sparingly
____	11.	Vegetable group	d.	2-4
____	12.	Meat group	e.	2-3
____	13.	Fats group		

TM 2.1

Nutrition Labels

Spaghetti Noodle Pasta-Enriched-Dry

MANDATORY LABEL

Nutrition Facts
Serving Size 2 oz. (60 g)
Servings Per Container 8

Amount Per Serving
Calories 220 Calories from Fat 10

	% Daily Value*
Total Fat 1g	1%
Saturated Fat 0g	0%
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 45g	15%
Dietary Fiber 1g	6%
Sugars 2g	
Protein 8g	

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 15%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower based on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65 g	80 g
Sat Fat	Less than	20 g	25 g
Cholesterol	Less than	300 mg	300 mg
Sodium	Less than	2,400 mg	2,400 mg
Total Carbohydrate		300 g	375 g
Dietary Fiber		25 g	30 g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Spaghetti Noodle Pasta-Enriched-Dry

VOLUNTARY LABEL

Nutrition Facts
Serving Size 2 oz. (60 g)
Servings Per Container 8

Amount Per Serving
Calories 220 Calories from Fat 10

	% Daily Value*
Total Fat 1g	1%
Saturated Fat 0g	0%
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 45g	15%
Dietary Fiber 1g	6%
Sugars 2g	
Protein 8g	

Vitamin A 0% • Vitamin C 0%
Calcium 2% • Iron 15%
Thiamin 40% • Riboflavin 15%
Niacin 25% • Vitamin B6 4%
Folate 2% • Vitamin B12 0%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower based on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65 g	80 g
Sat Fat	Less than	20 g	25 g
Cholesterol	Less than	300 mg	300 mg
Sodium	Less than	2,400 mg	2,400 mg
Total Carbohydrate		300 g	375 g
Dietary Fiber		25 g	30 g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

Lesson 2: Interpreting Food Labels

Name ________________

Nutritional Status

Objective: To illustrate the differences between a single day's diet and a five-day diet on overall nutritional status.

Activity Length: 30 minutes of class time to tabulate results

Materials and Equipment:

Nutritional labels from food consumed in one day

This should be gathered out of class. Each student should collect the "Nutrition Facts" panel from foods that would be eaten at breakfast, lunch, dinner and a snack (or two).

Calculator

Copy of USDA Handbook 8 (*Composition of foods: raw, processed, prepared*) or a nutrition textbook with food composition charts. Several fast food companies also have nutritional information on their products available at each store.

Procedure:

1. Fill in the blanks for chart 1 from the nutritional labels, information from Handbook 8, nutrition textbook, or other sources.
2. Fill in the information from labels for one day. Total the percentages for each nutrient. Determine the percentage of calories by dividing your number by 2000, and multiply the result by 100.
3. Get the nutritional information from five to seven other students. Fill in chart 2. Total the columns and average the percentages for each nutrient.

Key Questions:

1. In the single day analysis, what nutrients did you consume in excess amounts? What nutrients did you need to consume more of?

2. What happened when you combined the data from other students with yours? If you had eaten all of these meals, would your nutritional status be better or worse?

3. Using your single day analysis, choose one nutrient you consumed in excess amounts? What foods should you avoid in order to decrease your consumption of this nutrient?

4. Still using the single day analysis, choose one nutrient that you did not get enough of. What foods are good sources of this nutrient. (Use other nutritional labels or handbooks to get this information.)

Chart 1 - Your Values

Food	Calories	Total Fat	Cholesterol	Sodium	Total Carbohydrates	Dietary Fiber
Total						

Chart 2 - Nutrient Percentages From Other Students

	Calories	Total Fat	Cholesterol	Sodium	Total Carbohydrates	Dietary Fiber
Your values						
Total						
Average						

Developed by Douglas L. Holt, Assistant Professor, Food Science and Human Nutrition, University of Missouri-Columbia

Lesson 2: Interpreting Food Label Name ________________

Identifying Information on a Food Label

Objective: To identify information on a food label.

Product Name: ____________________

List the following information obtained from your food label.

1. Identification statement: ____

2. Net contents: ____

3. Name and address of manufacturer: ____

   ____

4. List of ingredients: ____

   ____

   ____

5. Nutritional information: ____

   ____

   ____

   ____

6. Which ingredient occurs in the greatest amount? ____________________

7. If additives are used, what are they? ____________________

8. List any artificial flavor(s). ____________________

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

Lesson 3: Nutritional Value of Beverages

Objective: The student will be able to compare the nutritional value of beverages.

Study Questions

1. **What are the nutritional benefits of beverages in the human diet?**
2. **How does the body utilize the fluids consumed?**
3. **What are the nutritional qualities of common beverages?**
4. **Why is milk considered nature's most nearly perfect food?**

References

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit IV.
2. Activity Sheet
   a) AS 3.1: A Test for Vitamin C

Lesson 3: Nutritional Value of Beverages

TEACHING PROCEDURES

A. Review

Review what can be learned from a food label. Re-emphasize the information that is required on a label: the identity statement, net contents, and the manufacturer's name and address. Relate how beverages have labels on them too. What are differences on the labels for milk, orange juice, coffee, and soda?

B. Motivation

1. Explain the origin of soda pop. Soda pop goes back to Greek and Roman times. "Medicinal" or natural mineral waters were valued for their refreshing qualities. In 1767, British scientist Joseph Priestly artificially carbonated water. An early method of obtaining the carbon dioxide was by acidification of sodium bicarbonate or sodium carbonate. From the use of these sodium salts, the name "soda" was given to these drinks. Gradually, fruit juices and extracts were added for flavor.

2. Bring a variety of soda cans, juice bottles, etc., to class. Examine the nutrients and ingredients.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss the nutritional benefits of beverages.

   What are the nutritional benefits of beverages in the human diet?

   a) Water source/fluid source
   b) Protein, carbohydrates
   c) Fat and minerals
   d) Vitamins

2. Discuss how the body utilizes the fluids people consume.

   How does the body utilize the fluids consumed?

   a) Medium for carrying nutrients via body fluids
   b) Solvent for organic and inorganic chemicals essential for life
   c) Carries nitrogenous waste products
   d) Controls and maintains body temperature

3. Discuss the nutritional qualities of some common beverages.

   What are the nutritional qualities of common beverages?

   a) Milk - fat, protein, carbohydrates, minerals, vitamins, water
   b) Carbonated soft drinks - water, carbohydrates, some provide Na and /or vitamins
   c) Coffee/tea - water and very little else
   d) Juices - water, vitamins, carbohydrates, minerals, and some proteins

4. Discuss why milk is considered nature's most nearly perfect food.

   Why is milk considered nature's most nearly perfect food?

   a) Premium quality protein - containing all essential amino acids
   b) Carbohydrate - only natural source of lactose
   c) Milk fat - easily digested
   d) Calcium and phosphorus
   e) Vitamins - milk contains all vitamins known to man

F. Other activities

1. Complete one or more of the following labs from The Chemistry of Beverages, Flinn Scientific, Inc., P.O. Box 219, Batavia, IL 60510, (708) 879-6900.

   a) Lab #1: Testing Milk for Calcium
   b) Lab #2: Density and Carbonated Beverages
   c) Lab #3: Caffeine Drinks
   d) Lab #4: The Juices

G. Conclusion

Beverages are a necessary part of a healthy diet. Because the human body is 60-65 percent water, water intake is vital. Water comes disguised in other beverages that may supply food nutrients as well. Milk is the most complete beverage.

H. Competency

Compare the nutritional value of beverages

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. b
2. a
3. c
4. b
5. Medium for nutrient transport, solvent for chemicals, carry waste products, controls body temperature

6. Alcohol is a toxic substance that, when broken down by the liver, produces extra hydrogen atoms. These in turn allow normal breakdown of sugars, amino acids and fatty acids to be incomplete. These incompletely digestive molecules are converted to fat globules which swell the liver and cause cirrhosis

Name ________________

Lesson 3: Nutritional Value of Beverages

Date ________________

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which common beverage contains the least nutrition?

   a. Soda
   b. Coffee
   c. Milk
   d. Apple juice

2. Which minerals are not found in milk?

   a. Iron and copper
   b. Calcium and phosphorus
   c. Potassium and chlorine
   d. Sodium and sulfur

3. What percentage of your body is water?

   a. 40 percent
   b. 50 percent
   c. 60 percent
   d. 75 percent

4. Which statement is NOT true about milk, nature's most perfect food?

   a. Milk contains all essential amino acids.
   b. Milk contains all necessary minerals.
   c. Milk contains all vitamins.
   d. Milk is the only food in nature that contains lactose.

Complete the following short answer questions.

5. List three functions of fluids in your body.

6. Describe how alcohol negatively affects your health.

Lesson 3: Nutritional Value of Beverages

Name ________________

A Test for Vitamin C

Objective: To identify beverages that contain vitamin C and to determine the relative amount of vitamin C in a beverage when compared to another beverage or another brand.

Activity Length: One class period

Materials and Equipment:

Milk - 2 different milk fat percentages - whole and skim
Orange juice - 2 brands - Brand A and Brand B
Soda pop - 2 brands - Brand X and Brand Y
Coffee - 2 brands - Brand P and Brand Q
Calibrated measuring beaker
4 beakers
120 ml distilled water
Indophenol blue dye
Eyedropper
4 test tubes
Test tube rack
Labels (masking tape will work)

Procedure:

Part 1

1. Label beakers A, B, C, and D
2. Measure 30 ml of whole milk into beaker A.
3. Measure 30 ml of brand A orange juice into beaker B.
4. Measure 30 ml of brand X soda into beaker C.
5. Measure 30 ml of brand P coffee into beaker C.
6. Add 30 ml distilled H_2O to each beaker (A, B, C, and D).
7. Gently swirl each beaker to mix liquids.
8. Using the eyedropper, measure 10 drops of indophenol blue dye into 4 test tubes. Label test tubes A, B, C, and D.
9. Carefully add contents of beaker A into test tube A one drop at a time, counting the number of drops needed to make the blue color disappear. Stop adding drops when the color disappears. Record the number of drops added to the test tube.
10. Clean eyedropper before moving to next beaker.
11. Repeat steps 8 and 9, using beaker B with test tube B, so on, with beakers C and D.
12. Vitamin C bleaches the blue color out of indophenol blue. This lab will make qualitative distinctions between beverages based on the amount of vitamin C they possess. The fewer the number of drops needed to make the blue color disappear, the greater the percentage of vitamin C in that beverage. If the blue color does not disappear, the beverage is said to contain no vitamin C.

Part 2

1. Choose to test either the two types of milk, or the two brands of orange juice, soda, or coffee.
2. Clean beakers and test tubes.
3. Repeat steps 1-12 of part 1, using only 2 beakers and 2 test tubes.

Part 1	# drops	rank in order of vit. C content
beaker A ____________		
beaker B ____________		
beaker C ____________		
beaker D ____________		
Part 2		
beaker A ____________		
beaker B ____________		

Key Questions:

1. Which beverage contains the most Vitamin C?

2. In Part 2, was there a difference in Vitamin C levels?

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH

Lesson 4: Relationship Between Diet and Health

Objective: The student will be able to describe the relationship between diet and health.

Study Questions

1. **How does cholesterol affect human health?**
2. **Why is the composition of fat in food important?**
3. **What is the relationship between dietary fiber and health?**
4. **What are major health issues affected by nutrition?**
5. **How can health problems be minimized through proper nutrition?**

Reference

1. Martin, Phillip R. *Food Science and Technology* (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1994. Unit IV.

TEACHING PROCEDURES

A. Review

Review the value of beverages to a person's diet. Concentrate on milk. You may want to briefly discuss the fact that calcium is a necessary mineral which is readily available in dairy products. Research indicates that calcium uptake from a person's diet is significantly reduced around age 30-35.

B. Motivation

1. Fry potatoes with saturated (coconut, palm, lard), monounsaturated (canola, olive, peanut), and polyunsaturated (sunflower, safflower, corn, soybean, sesame) fats. Do a taste test. Question students about different fat types to determine how much they know about fat.

2. Have students keep a weekly diet journal. At the end of the week, discuss whether their diets were balanced.

C. Assignment

D. Supervised study

E. Discussion

1. Discuss how cholesterol affects human health.

   How does cholesterol affect human health?

   a) Necessary for building membranes, manufacture of hormones and vitamin D, and other body functions. The liver produces cholesterol when diet intake is insufficient.
   b) High total blood cholesterol level is a major risk factor in the development of coronary heart disease
   c) Low-Density Lipoprotein is called bad cholesterol
   d) High-Density Lipoprotein is called good cholesterol

2. Discuss why the composition of fat is important.

   Why is the composition of fat in food important?

   a) Fats add flavor, aroma, texture, and satisfaction (satiety) to a meal
   b) High energy source - 9 calories/gram
   c) Transport and absorb fat-soluble vitamins A, D, E, and K
   d) Composed of fatty acids - a fat may contain two or more types of fatty acids. Classification is based on the predominant type of acid structure.
      1) Saturated fatty acids
         (a) Come from animal sources and coconut, palm, palm kernel, and vegetable oils
         (b) Should compose 1/3 or less of total fat intake
         (c) Can raise blood cholesterol

2) Monounsaturated fatty acids
   - (a) Found in animal and plant fats especially olive, canola, and peanut oils
   - (b) Should compose 1/3 or less of total fat intake
   - (c) May help lower blood cholesterol

3) Polyunsaturated fatty acids
   - (a) Come from sunflower, safflower, corn, sesame, and soybean oils
   - (b) Can help lower blood cholesterol
   - (c) Linoleic acid is an essential fatty acid needed for normal growth

e) Should contribute no more than 30 percent of caloric intake

f) Triglycerides - edible oils and fats composed of three fatty acids attached to glycerol

3. Discuss the relationship between dietary fiber and health.

What is the relationship between dietary fiber and health?

a) Fiber provides bulk and roughage which contribute to a healthy intestine.
b) Fiber holds water, loosens stool, and decreases transit time through colon.
c) It can lower serum cholesterol, decrease incidence of colon cancer, and lower the insulin requirements of diabetics.
d) Excessive fiber can bind minerals making them unavailable for absorption.

4. Discuss the major health issues affected by nutrition.

What are major health issues affected by nutrition?

a) Starvation
b) Obesity
c) Heart disease
d) Bulimia and anorexia
e) Cancer
f) Malnourishment - osteoporosis, night blindness, dermatitis, beri-beri, neuritis, photophobia, anemia, pellagra, scurvy, rickets, hemophilia
g) Diverticulitis
h) Ulcers
i) Decreased recovery time after illness or surgery

5. Discuss how health problems can be minimized through proper nutrition.

How can health problems be minimized through proper nutrition?

a) Balanced diet plus exercise
b) Meet RDA's
c) Remain in weight range/caloric intake
d) Diet modification if necessary

F. Other activities

1. Have a Red Cross employee or school nurse speak about or demonstrate a blood iron and cholesterol test.

2. Invite a dietician to speak about his/her job.

3. Each student should monitor food intake for one day and determine if daily values were met, at what level, and what the caloric intake was.

4. Assign students to examine the type of cooking oil(s) used at school, their home, and a local cafe or restaurant. Determine if oils are saturated, monounsaturated, or polyunsaturated fats.

G. Conclusion

This lesson should remind students that their health is directly related to their diet. Issues such as cholesterol, fat, fiber, and dietary diseases are very prevalent. A closer examination of one's diet is always a desirable action.

H. Competency

Describe the relationship between diet and health.

Related Missouri Core Competencies and Key Skills: None

I. Answers to Evaluation

1. natural
2. necessary
3. different than
4. LDL
5. increase
6. c
7. b
8. a
9. age, heredity, gender

10. Retains water, loosens stool, and decreases transit time through colon. Possibly lowers serum cholesterol, decreases colon cancer, and lowers diabetic insulin requirements.
11. Three of the following: starvation, obesity, heart disease, bulimia and anorexia, cancer, malnourishment
12. Three of the following: balanced diet, follow RDA's, exercise, appropriate caloric intake, proper diet modification

UNIT IV - FOOD SELECTION AND CONSUMER HEALTH Name ______________________

Lesson 4: Relationship Between Diet and Health Date ______________________

EVALUATION

Circle the word in parentheses to complete the sentence correctly.

1. Cholesterol is a (synthetic, natural) compound.

2. Cholesterol is a (necessary, unnecessary) component of cell membranes, and hormone and bile production.

3. Blood cholesterol is (identical to, different than) dietary cholesterol.

4. (High-Density Lipoprotein, Low-Density Lipoprotein) is referred to as "bad" cholesterol.

5. Diets high in total and saturated fats tend to (increase, decrease) cholesterol levels.

Match the types of oil with their appropriate molecular structure description.

____ 6. Palm and coconut oils
____ 7. Olive, peanut, and canola oils
____ 8. Soybean and sunflower oils

a. Polyunsaturated
b. Monounsaturated
c. Saturated

Complete the following short answer questions.

9. Name two factors, other than diet, that affect a person's cholesterol level.

10. How can dietary fiber aid nutrition?

11. List three diseases/disorders caused by poor nutrition.

12. What are three keys to minimizing health problems?

Country Curing Hams

Agricultural Guide
Published by the University of Missouri-Columbia Extension Division

Country curing hams

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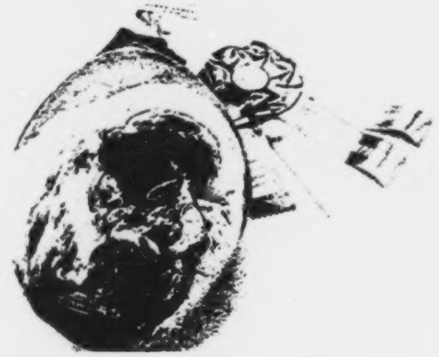

Photo: Grand champion ham at the 1983 Boone County Fair.

Many people like the flavor of ham that has been cured country style. Its characteristic flavor is quite different from mild-cured commercial hams.

Time to cure

When production of country cured hams is dependent on natural conditions for refrigeration, hams should be placed in cure during December and January. This will help ensure production of sound cured and aged hams that will have acquired their characteristic flavor and aroma by midsummer. Unless mechanical refrigeration is available, hams should not be placed in cure after January. Thirty to 40 days of cool weather (less than 40 degrees F night temperature) is needed, depending on the size of the hams, to prevent spoilage.

The fresh product

To cure hams country style, begin with fresh hams that have been chilled to about 40 degrees F within 24 to 30 hours after slaughter. If the source of hams is a commercial packing plant, this requirement is usually met; however, if the source of hams is farm slaughter, take care to chill the carcasses as rapidly as possible. Regardless of the source, apply cure within 48 hours after slaughter. Before the cure is added, trim the hams of excess fat and bevel to the desired shape, being careful not to expose any more lean than necessary.

Curing ingredients

Salt is the primary curing agent, but sugar is added to offset some of the harshness of the salt. Other ingredients, such as black pepper, red pepper, and ground cloves, are sometimes added to give a characteristic flavor, aroma, and color. Saltpeter (potassium nitrate) is traditionally used to aid in color development, flavor, and preservation.

Curing mixtures

Two curing mixtures are as follows:

A basic curing mixture

- 2 lbs. salt (non-iodized)
- 1 lb. sugar (white or brown)
- 1 oz. saltpeter (optional)

Mix thoroughly.

Another successful recipe

- 2 cups salt
- 8 T. light brown sugar
- 4 T. black pepper
- 2 T. red pepper
- ½ tsp. saltpeter

Mix thoroughly.

Applying the curing mixture

The curing mixture should be applied at the rate of 1¼ ounces per pound of ham.

1. Apply the cure to the ham by opening the hock end and forcing three tablespoons of cure into the opening. This gets the cure to the joint in the middle of the ham which decreases the chance of bone sour or spoiling.
2. Frost the skin side with cure and place the ham in proper position on wrapping paper.
3. The remaining cure must be placed on the cut surface of the ham.

4. Wrap the paper tightly and smoothly around the ham to hold the cure in place and place in a stockinette. The ham should be handled carefully during bagging and wrapping to keep the cure in place. You can leave the ham on a table or shelf until the cure is wet, which helps keep the cure in place. This usually takes 1 day.

Caution: Moisture must escape from the hams—do not use plastic or waxed paper.

Hang the ham shank down in a well-ventilated area. We do not recommend moist areas like basements and cellars.

Allow the hams to cure 2½ days per pound of ham. If the hams freeze during curing, allow one additional day for each day they are frozen.

Preparation for aging

At the end of the curing time (minimum of 2½ days per pound of fresh ham), unwrap and remove any excess cure and mold. Use vinegar and a cloth to remove mold. Blot dry and apply a light covering of vegetable oil to retard mold development. Curing is usually complete around April 1.

Aging

Hams should be aged for three to six months to acquire their characteristic flavor. The variation in temperature during the spring and summer enhances the flavor. You can leave the hams wrapped for aging. If the area is well-ventilated, you can leave them where they were cured for the aging period.

Caution: Age the hams hanging in a stockinette with shank down. This position helps to improve the shape and conformation and permits better moisture drainage.

Smoking

In Missouri, most country cured hams are not smoked; however, some people desire the smoked flavor and color. For smoking, the hams should be unwrapped after curing time. Remove any excess curing mixture and any mold growth by brushing with a stiff brush and rinsing with cold water. Smoke hams so that heat does not exceed 85 to 90 degrees F. Use hardwood logs or sawdust as the source of smoke. Don't use resinous woods, such as evergreens, for smoking. After smoking, rewrap the hams and hang for aging.

General protective measures

Cured hams must be protected from insects and rodents. The doors and windows should be screened with 32 mesh screen and all cracks sealed.

However, if the hams are completely wrapped so that the entire ham is covered with paper as described, the insect-proof storage area is not necessary. No insecticide is approved for spraying or brushing on the meat or on table tops or meat shelves where meat is likely to make contact. Therefore, good sanitation is essential in all phases of ham curing. Hams should be examined at least monthly for insect or rodent damage.

Preparation for showing

If the ham is to be displayed, prepare it as follows:

1. After aging, unwrap and remove any mold growth. This may be done either by washing in warm water and blotting dry or by using a stiff bristled brush, followed by rubbing with a cloth or sponge dampened with vinegar.
2. When the ham is cleaned, remove the part of the aitch bone that is above the meat surface. You will improve appearance if you saw about one inch off the shank. You may want to do other trimming to improve the overall appearance. Rub the entire ham with a light coat of vegetable oil. A light covering of paprika may be applied.

Points considered in judging hams

- Eye appeal
- Color
- Smoothness of skin
- Fitting
- Trim
- Firmness
- Meatiness
- Aroma

Meatiness or lean-to-fat ratio and aroma are the most important characteristics.

Cooking country ham

Once the ham is aged, prepare the ham for cooking by removing excess cure and any mold that grew during aging. The two common methods of cooking country ham are frying and baking.

To fry, slice the ham approximately ¼-inch thick. Cook slowly and turn often. Don't overcook. If ham is unusually lean, add some fat to the skillet. Some people prefer to fry the center slices and bake the shank and butt portions.

To bake a whole ham or the portions, simmer (not boil) in water for 20 to 25 minutes per pound of ham. Take out of water, remove the skin, place in roasting pan with fat side up and bake uncovered in 275 degrees F oven until the internal temperature is 155 degrees F. A pineapple-clove garnish or other garnishes or glazes may be used on the ham during or after baking.

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Homemade Cottage Cheese

Agricultural Guide

Published by the University of Missouri-Columbia Extension Division

SMALL FARM FAMILY PROGRAM SERIES

Homemade Cottage Cheese

Harold J. Bassett, Department of Food Science and Nutrition, College of Agriculture

Use one gallon of skim milk

Weight - 8.7 pounds (3950 grams)

Volume - 4.0 quarts (3840 cc)

Makes about 1.3 pounds of cottage cheese (593 grams)

Guide for estimating cost: If milk costs $1.00 per gallon, the cottage cheese curd will cost $0.77 per pound.

EQUIPMENT NEEDED

1. Double-boiler, of stainless steel, if possible. To handle one gallon of milk, the inner pan of the double-boiler should have a capacity of at least 6 quarts. *Do not* use aluminum or iron utensils.
2. Thin-blade stainless steel knife that is at least as long as the inner pan is deep.
3. A top-reading metal thermometer (a) is best, but a floating dairy or candy thermometer is satisfactory.
   (a) Weston #4200 thermometer, range from 0°F to 212°F with plastic lens. Cost, about $15. Available from most dairy supply houses.

Caution: Glass thermometers will break– so be careful if you use them.

4. One or two long handled stainless steel spoons that will reach to the bottom of the double-boiler.
5. A measuring cup that shows ounces or cc's. (One ounce is about 30 cc; four ounces is 120 cc.)
6. A piece of open woven cotton material, such as cheese cloth, about 1 1/2 foot square.
7. A large collander or wire strainer large enough to hold the cheese cloth and cheese while it drains. (Only stainless steel or smooth plastic should be used!)
8. A mixing bowl.
9. Covered containers for holding the cheese in storage. Clean, plastic refrigerator boxes for "left-overs" are good for this purpose.

HOW TO OBTAIN BUTTERMILK STARTER

There are two ways of obtaining cultured buttermilk (called "starter" by commercial cheesemakers):

Buy Commercial Buttermilk for Start

Fresh buttermilk purchased from the dairycase of a store is usually satisfactory for starting homemade cottage cheese.

If the buttermilk is very old, however, the lactic acid bacteria may have lost their ability to produce acid rapidly. In that case, the milk will neither sour nor develop a firm curd suitable for making cheese.

After a fresh carton of buttermilk is opened, it may be used for about one week to make more cheese. It must be kept *cold* and *clean* at all times.

Save From Previous Batch

About once a week, a fresh batch of buttermilk may be made from an older batch. Great care must be taken to prevent contamination during the reinoculation process. Use the following procedure to make fresh buttermilk (starter):

1. Select a few pint jars with good lids.
2. Clean the jars and lids thoroughly, and let them dry without wiping.
3. Fill the jars about 2/3 full of *fresh, clean* skim milk, and screw the lids on loosely.
4. In a pressure cooker, heat the milk to 15 pounds for 10 minutes (the procedure is similar to canning foods).
5. Let the pressure cooker cool completely before opening.
6. Store the sterilized milk in a refrigerator until needed.
7. When fresh buttermilk is needed:
   (a) Warm one of the pint jars of milk to 72°F.
   (b) From a container of fresh buttermilk, carefully pour about one tablespoonful into the sterile 72°F milk. (Be Careful! It is at this point where most contamination takes place.) Use the remainder of the fresh buttermilk to make a batch of cheese or for drinking.
   (c) Cover the freshly made culture with a loose lid, rotate to mix without letting the milk touch the cloth or lid, and store at 72°F-75°F for 16-24 hours. At that time the buttermilk fermentation should be completed. Store the new buttermilk in the refrigerator until it is needed for further inoculation or use to make cheese.

Cultures may be carried successfully through many inoculations if care is taken. However, it is best to start with new buttermilk from the store after five or six inoculations.

PROCEDURE FOR MAKING COTTAGE CHEESE

There are two distinct procedures for making cottage cheese: (1) The "long-set" method produces a small curd, high acid cheese, and takes about 15 hours to complete. Long-set cheese is made without rennet. It may be called "acid curd", "country style," or "farmer's cheese."

(2) The "short-set" method produces a large curd, low-acid cheese. Short-set cheese is made with rennet and takes about five hours to complete. It may be called "sweet curd," "flake type," "rennet curd," or "popcorn cheese." The use of rennet shortens the making process, produces larger curds, and reduces the shattering of curd that leads to losses of cheese in the whey.

There are a few differences in the making procedures between long-set and short-set cottage cheeses. The two procedures are outlined below.

Under the most ideal conditions, cottage cheese made at home is not likely to be as good as that bought from the dairy shelf. On the other hand, making cheese at home can provide a high quality food at medium cost. It may be consumed alone or with any other food item.

Long-Set, Small Curd Method
(15-24 hours)

Pasteurization

Heat the skim milk, with constant stirring, to 160°F in a double boiler. When the temperature reaches 160°F, remove the boiler from the heat and quickly cool the milk to 72°F. Use ice for cooling if available.

Important: From this point on until the curd is ready for cooking, which will be in about 15 hours, keep the milk at about 72°-75°F. Good cheese cannot be made if this is not done!

Short-Set, Large Curd
(5-6 hours)

Pasteurization

Heat the skim milk the same way, but cool to 86°-88°F.

Keep milk at 86°-88°F until ready for cooking, which will be in about five hours.

Long-Set, Small Curd Method

Ripening the Milk

Add four tablespoons (1/4 cup) of starter (buttermilk from a store or previous batch) to the milk and stir for one minute.

Cover the milk with a loose lid or clean cloth, and *do not disturb* for 15-24 hours. The milk will develop into a soft curd.

The proper curd development can be determined by sliding a thin knife down the vessel wall to the bottom and pulling the blade away from the side. The curd development is complete if the curd pulls cleanly from the wall. If the curd sticks to the wall, continue testing at two-hour intervals until a satisfactory test is obtained.

Cutting the Curd

The curd must be cut into cubes of about 1/4 inch square. See Figure 1.

Important: the curd has been held at 72-75°F for 16-24 hours. Cooking the curd will begin now. Good cheese cannot be made unless the cooking procedure is done correctly.

Cooking the Curd

Add 72°F water to the outer double-boiler until the water level is above the level of the curd in the inner boiler. Layer about two inches of the same temperature water on top of the freshly cut curd. Slowly and steadily heat the water so that the temperature of the curd increases about 1°F per minute. Let the temperature in the curds and whey rise to 100°F in 30-35 minutes. Gently stir the curd for one minute, at about five minute intervals. The curds will stick together if not stirred sufficiently.

When the whey temperature reaches 100°F, increase the rate of heating to 2°F per minute. Stir the curd at two minute intervals. In 10-15 minutes the temperature of the whey should be 115-120°F, at which point the heat should be turned off. Hold the curd at this point for 15-20 minutes, using additional heat when necessary to maintain the temperature. Stir carefully to keep the curd separated and heating evenly.

The rising acidity produced by the lactic bacteria, plus the heat from cooking, causes the curds to lose whey and become smaller and tougher. With a little experience, the cheesemaker can determine the processing conditions that give the best cheese. A test for proper amount of cooking is to drop a curd onto a pan on the floor. A properly cooked curd will

Short-Set, Large Curd Method

Ripening the Milk

Use eight tablespoons (1/2 cup) of starter (cultured buttermilk from store or previous batch). Follow other directions stated in long-set method.

After the starter has been in for one-half hour, add *rennet* and stir. (*Rennet is a natural substance that aids in the curdling of milk for cheesemaking. It is available from most stores under the name of* "Junket.")

Use one-fourth (1/4) tablet of Junket per one gallon of milk. Dissolve the Junket in two tablespoons of water just before adding it to the milk. The rennet aids in producing a firm curd and preventing matting of the curd during heating.

Cutting the Curd

Cut the curd into cubes of about 5/8 inch size. See Figure I.

Test the curd for firmness as in the long-set method.

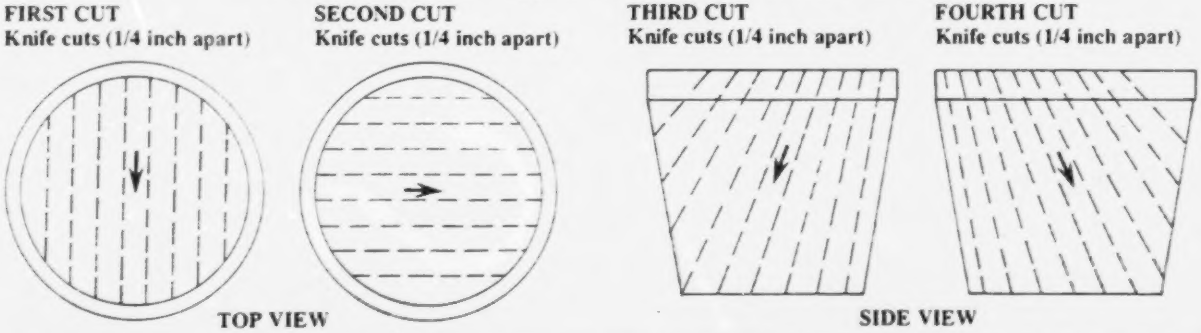
Cooking Curd

In the outer pan of the double boiler add enough 115°F water to reach a level about two inches higher than the level of the curd in the inner pan. Layer two inches of 115°F water on top of the curd in the inner pan. Slowly heat the cheese with careful stirring, at a rate of about 3°F each 10 minutes, until the temperature reaches 115°-118°F. Leave the curd at this temperature for 15-20 minutes. The curd should be firm enough at this point to drain the whey.

Long-Set, Small Curd Method	Short-Set, Large Curd Method
bounce without shattering into pieces. At that point the cooking should be stopped.	
Draining the Whey and Cooling the Curd Quickly dip most of the whey off the curd. Pour the curd and remaining whey onto a cheese cloth spread over a colander. Let the curd drain for 3 to 4 minutes. Lift the cheese in the cloth from the colander and submerge it in cold water. Dip the curd in and out of the water several times to rinse out the whey, and to cool and separate the particles of curd. Repeat the dipping process in fresh, cold water (ice water is best). Repeat the dipping if the curd is still not cold. Put the bag of cold curd back in the colander to drain until dry. Complete the draining in the refrigerator. If the curds are firm, the cheese will not mat together, even if left overnight. The dry curd may be packed in a clean plastic or glass container until used. The curd may be salted by adding salt to taste and stirring in a clean bowl. Store the salted curd in a refrigerator until used. The whey makes excellent hog or chicken feed when mixed with grain.	Follow directions as in the long-set method.
Making Creamed Cottage Cheese To make "creamed" cottage cheese, stir six tablespoons of sweet cream or half-and-half into the cottage cheese. The cream should be added to the cheese after the curds have been chilled in the refrigerator.	Follow directions as in long-set method.

Properly made cottage cheese will remain good for one to two weeks if kept cold. But it will quickly become acid, develop off flavors, or mold and yeast will grow in it if it is allowed to warm up.

How to Cut Cottage Cheese Curd With a Knife



FIRST CUT
Knife cuts (1/4 inch apart)

SECOND CUT
Knife cuts (1/4 inch apart)

THIRD CUT
Knife cuts (1/4 inch apart)

FOURTH CUT
Knife cuts (1/4 inch apart)

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Food Science & Technology

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FOREWORD

The development of the Food Science and Technology curriculum guide is the result of suggestions by the MVATA Teaching Aids Committee. The Food Science and Technology Advisory Committee suggested the topics to be included and reviewed the materials.

This four-unit curriculum contains 23 lessons. Topics include: food preservation, food perishability, food processing, food product development, products and by-products, grading and inspection, food safety, food deterioration, nutritional properties of foods, biotechnology, food selection, and consumer health. An instructor's guide can be purchased separately.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, the director of Vocational Education applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

This guide incorporates the needed component parts to aid agriculture teachers in the implementation of VIMS. For ease of use, performance objectives and competencies have been included at the beginning of the guide as well as incorporated within each lesson. A competency profile has been provided in the front of the guide for convenient record keeping.

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FOOD SCIENCE

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Lesson 1:
Introduction to Food Preservation

America is blessed with an abundance of food. Citizens from a developing country would see more food in one trip to an American grocery store than they would see in a lifetime at home. The United States enjoys the widest variety of healthy foods at the lowest cost relative to income that can be found in the world. Americans enjoy the combination of educated food producers/processors, abundant natural resources, a diverse climate, and advanced food science and technology.

Food scientists have identified the causes of food deterioration. Food technologists have developed techniques to preserve food. The team concept of food science and food technology allows each of us to leave the grocery store with confidence that we have purchased wholesome food.

Why Foods Are Preserved

Food production is often cyclical, while food consumption is more constant. Therefore, foods must be preserved to ensure an abundant supply throughout the year. For a variety of economic, climatic, and political reasons as many as 10,000 people die each day worldwide due to starvation and malnutrition. Food is also preserved in order to prevent microbial growth. A third reason food is preserved is to maintain and enhance its taste and texture by reducing the effects of chemical changes. Also, foods are preserved to provide products in more convenient forms.

Importance of Food Preservation

Ultimately, food preservation is necessary for the preservation of life. Food preservation was also important historically, is presently, and will continue to be in the future. History has shown that early civilizations developed in fertile, food producing areas. Humans learned to sun-dry certain types of foods so they might be eaten at times other than harvest.

Preservation of food was of great importance to Napoleon and his armies. His military campaigns were successful because he provided his troops with adequate food. Napoleon suffered his greatest defeat when it became difficult to feed his troops.

Later it was discovered that salt extended the storage life of foods. Spices and sugar were used as food preservatives by early Asians. American colonists and pioneers depended on salted, pickled, and smoked meat and fish in addition to dried beans. The cold winter temperatures were also useful to process and preserve meats. Lard was melted and spread over cooked sausages for protection. Fruits and vegetables were stored in root cellars, buried, or dried. The cool temperature of the spring house was valuable for storing eggs, milk, and butter.

The 1830's ushered in the railroad, making food transportation over long distances much faster. The refrigerated rail car of the 1880's was revolutionary! The 20th century has witnessed steady progress in food science and technology, which should propel the industry into a bright future.

How will food science and technology impact the future? The world's population continues to expand as the number of food producing acres declines. Therefore, techniques to preserve food will become increasingly important. The demand for convenience will prompt development of new preservation techniques. The added energy expense of refrigeration, freezing, and irradiation could be reduced by new technology. Medical advancements may necessitate other technological developments. Already, food sterilized by irradiation is required by certain chemotherapy patients. Future trends in food science may depend on people like you!

Food Preservation Techniques

Food may be preserved using a variety of techniques.

Heat - Heating food products is a technique used to destroy microorganisms and endogenous enzymes. Most microbial growth occurs between 61°-100°F. Heat-loving (thermophilic) microbes grow in the range of 110°-130°F. In order to destroy these microbes, food products must be heated to an internal temperature greater than 180°F. Heatenduring (thermoduric) bacteria survive temperatures as high as boiling so food is often canned under pressure to provide a temperature above 212°F. Sterilizing food means heating the food to about 240°F and maintaining that temperature for 15 minutes or longer.

Figure 1.1 - Food Preservation Techniques

- Heat
- Cold
- Drying
- Packaging
- Additives
- Fermentation

Cold - Refrigeration, or maintaining 33°-40°F, is useful to slow microbial growth. Freezing is achieved by reducing the temperature to 0°F or lower, which virtually stops enzymatic action and microbial growth.

Drying - Dehydrating is the removal of moisture to limit microbial and chemical activity. Freeze-drying is the removal of moisture from a frozen food under reduced atmospheric pressure.

Irradiation - Irradiation is a technique that uses gamma rays or beta particles to bombard and kill microbes and inactivate enzymes.

Packaging - Vacuum packaging is the removal of most of the oxygen from food products. This prevents aerobic microbial activity and is usually applied during packaging of refrigerated solid foods. Sometimes an atmosphere rich in CO_2 is used to preserve food, particularly fruits and vegetables. Often the packaging material is very important in creating and maintaining the desired conditions. This type of process is called modified or controlled atmosphere packaging, commonly referred to by the acronym MAP/CAP.

Additives - The use of additives or chemicals to prevent microbial growth is another preservation technique. Sweetening, or achieving a high sugar content, produces a high osmotic pressure which causes water to be withdrawn from microbes. A 70 percent sugar level is necessary to prevent all microbial growth. Salting produces a high osmotic pressure or low water activity (Aw) and restrains microbial growth. Salt levels of 2.5-3.0 percent are common in salt cured food products. Smoking food products allows formaldehyde and phenolic compounds to settle on the food surface. The compounds inhibit microbial growth. Spicing is a technique used to slow the growth of some microbes. However, processors must use spices that are free from undesirable microbial contaminants.

Fermentation - Fermenting, also known as souring or pickling, slows bacterial growth. Acids produce a low pH, which restrict microbial growth. Sometimes, desirable microorganisms are allowed to grow in the food. They convert carbohydrates into acids or alcohol. These by-products inhibit the growth of undesirable microorganisms and provide unique flavors in foods. The use of desirable microorganisms to preserve food is called fermentation. Bacteria convert carbohydrates into acids and alcohol.

Causes of Food Deterioration

Food is subject to physical, chemical, and biological deterioration. In practical terms, food starts deteriorating at the time it is harvested or slaughtered. The critical question becomes: How slow or how rapid is this process? The principle causes of food deterioration are heat, cold, light and other radiation, oxygen, moisture/dryness, natural food enzymes, microorganisms, macroorganisms, industrial contaminants, and time.

Microorganisms, like bacteria, mold, and yeast, ferment sugars and hydrolyze fats, proteins, starches and cellulose. Those that hydrolyze fats produce rancidity. Those that digest proteins make putrid odors. Others produce acid, make food sour, and discolor it. A few produce toxins that can lead to food poisoning.

Natural enzymes can become catalysts of chemical reactions in food. Ripening and tenderizing are examples of natural enzymatic reactions. Some reactions, like the aging of beef or the ripening of tomatoes, are desirable if they are not allowed to continue too far. Tenderizing and ripening beyond an optimal point causes deterioration.

Pests include insects, parasites, birds and rodents. Insects are very destructive to cereal grains, fruits, and vegetables. While an insect may create only a small hole in a melon, this allows microorganisms to invade and cause decay. Freezing, irradiation, and O_2 removal are commonly used to kill insects in food. A common food-borne parasite is Trichinella spiralis. This worm can enter hogs that eat uncooked animal food wastes. If an infected pork carcass is cooked insufficiently, this parasite can enter man. Fish may also harbor parasitic worms that can enter the consumer if the fish is eaten raw.

Rodents, such as rats, not only consume large quantities of stored grain, but also contaminate it with bacteria-infested feces and urine. Flies, rats and cockroaches are all known to transmit disease causing microorganisms to food. For example, rats can transmit salmonellosis, leptospirosis, typhus fever, the plague, and other infectious diseases.

Other Factors - Heat can denature proteins, break emulsions, dry out food, and destroy vitamins. Within the temperature range of 50°-100°F, chemical reaction rates double for every 18°F rise in temperature. These chemical reactions include both enzymatic and non-enzymatic reactions.

Cold temperatures (i.e., below freezing) disrupt the texture and crack the skins of fruits and vegetables. Freezing milk breaks its emulsion and curdles its protein. Temperatures that are too cold cause off-colors, surface pitting, and decay, especially in fresh fruits and vegetables.

Light destroys some vitamins, specifically riboflavin, vitamin A, and vitamin C. It also can cause food discoloration. Ultraviolet light oxidizes milk fat and protein and changes milk's flavor. Not all wavelengths of radiation are absorbed equally. Gold colored filters for fluorescent lights in display cases and opaque packaging are preventative measures.

Moisture or dryness are factors that may contribute to food deterioration. Moisture is required for all microbial growth and for chemical reactions. Too much moisture can cause lumping, crystallization, and stickiness of dried food products. Too little moisture in baked foods can cause dehydration and staleness. Even when fruits and vegetables are placed in a moisture-proof bag, water is given off through respiration and transpiration and the produce shrivels.

Oxygen can have negative effects on vitamins A and C, food color, flavor, and other constituents. Oxygen's presence is essential for mold growth. Oxygen can be removed by deaeration (inert gas purging), vacuum packaging, or flushing containers with nitrogen (N_2) or carbon dioxide (CO_2).

Industrial contaminants are a minor cause of food spoilage. Chemicals may inadvertently come in contact with food and cause discoloration and off-flavors.

Most of these factors are dependent on how long the food is stored. As more time passes, the causes of food deterioration (explained above) are more likely to cause food spoilage. Food quality decreases over time. Two common sense rules of food preservation are: 1) keep food alive as long as possible, and 2) following harvest or slaughter, the product must be cleaned, and preserved as quickly as possible.

Storage Time and Type Affects Food Quality

The type of storage affects food quality. Of course, food needs to be wholesome in the beginning. How the product was handled immediately following harvest also directly affects food shelf life (the time it is satisfactory to eat). Most fruits and vegetables need a refrigeration unit in the field at the time of harvest. The shorter the time required to cool food products to 33°-40°F, the longer they can be stored. For example, sweet corn will metabolize its own sugar (convert its own sugar into starch) following harvest. At 32°F only 10 percent of its sugar will be converted to starch in one day. At 68°F 25 percent of its sugar may be converted in one day. The use of portable hydrocoolers that jet spray fresh produce with cold water is highly beneficial. The water may contain a germicide to inactivate surface microbes. Nitrogen gas can also be used to induce evaporative cooling. Animal carcasses must be cooled to an internal temperature of 36°F within 24 hours of slaughter.

Another critical factor affecting long-term storage is the relative humidity (RH) during storage and handling. Most microorganisms thrive in moist environments. Therefore, relative humidity levels must be carefully controlled. Underground caves used for food storage provide a fairly static and low RH. Insufficient moisture can also cause dehydration of food. Beef stored at less than 90 percent RH dries out. If RH is between 90-98 percent, the beef will mold. If above 98 percent, the bacteria will cause spoilage. Meat tissue may be covered with a film of plastic to decrease moisture loss. Cheeses can be wrapped in impermeable films to prevent drying out. Eggs may be coated with a thin firm of mineral oil to maintain desirable moisture levels.

Refrigeration refers to temperatures of 30°-61°F. Most foods may be preserved for days to weeks at these temperatures. Freezing temperatures are below 30°F. Foods can be preserved for months to years. Neither refrigeration nor freezing completely destroys all microbes. Once food is thawed, rapid microbial growth is possible. Refrigeration is one of the gentlest methods of food storage in terms of maintaining taste, nutritive value, and texture. Refrigeration accelerates the staling of breads. Food stored long-term must be sterilized, dehydrated, irradiated, fermented, or completely frozen.

Summary

Food preservation is necessary to maintain human life. We preserve food for human safety, quality enhancement, convenience, and to maintain an adequate supply. Food preservation will be as important in the future as it has been in the past. Controlling microbes and enzymatic activity are the goals of a variety of preservation techniques. If these techniques are not used, physical, chemical, and biological deterioration are possible. The time and method of food storage are other major factors that influence food quality.

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Lesson 2: Food Perishability

Food is a perishable commodity. The storage life, however, depends on a variety of factors as well as which food product you are considering. Egyptians stored wheat very well. Recently, some Egyptian wheat stored for more than 3,000 years was discovered. This wheat was still suitable for use as food. Other products, like fresh, uncooked meat can spoil within a few hours if left at room temperature.

Food Characteristics Influence Deterioration Rate

Deterioration rate is influenced by the characteristics of the food product. The pH, or hydrogen ion concentration, affects how long food will stay fresh. In general, foods spoil fastest when pH lies between 6 and 8 (Neutral pH is 7.0).

The moisture, or water activity level, is another important food characteristic that influences deterioration rate. All microorganisms require moisture to survive. Foods with very little water content will not support microbial growth. The water activity level of foods must be reduced to 0.6 or below to prevent all microbial growth. Foods with a water activity near .99 support microbial growth best. Moisture may be removed by heating the food or by adding salt or sugar to the food, which by the process of osmosis, removes water from the microbe's cytoplasm.

Deterioration rate is also affected by the temperature of the product. Foods deteriorate fastest at temperatures between 60°F and 100°F.

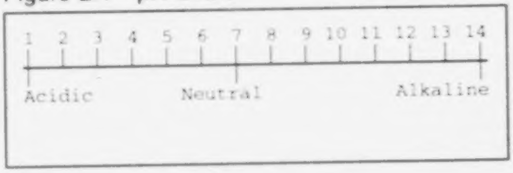
The oxygen level of the food product is another important consideration. If the oxygen has been removed from the food by vacuum packaging, the growth of molds and aerobic bacteria will be stopped, but anaerobic microorganisms may flourish.

The physical characteristics of the food are also factors that influence deterioration rate. The degree of ripeness, whether immature or overmature, can have a dramatic effect on the food's perishability rate. The actual size of the product, or its surface area, is another important physical characteristic. In the case of meat, the whole carcass is less vulnerable to deterioration than steaks or ground meat because the whole carcass has less exposed surface area per unit of weight or volume. Because retail cuts such as steaks have more surface area, they provide a more readily available source of nutrients, oxygen, and water for the microbes than do whole carcasses.

Acidity/Alkalinity Influence on Perishability of Foods

The pH readings of most foods vary from about 2.6 to 7.0. Some examples are: dill pickles, pH 2.9; apples, pH 3.0; tomatoes, pH 4.2; sweet potatoes, pH 5.4; and shrimp, pH 6.9. The perishability of food products is dependent upon their degree of acidity or alkalinity. On the pH scale of 0-14, an alkali is any substance with a pH of 7.1-14.0. An acid has a pH of 0-6.9. Alkalis have a bitter taste; therefore, very few food products are alkaline. Stored eggs and soda crackers are examples of alkaline foods.

Figure 2.1 - pH Scale



An alkaline pH reading above about 8.0 slows or inhibits microbial growth. An acid modifies or denatures bacterial protein, and some acids are directly toxic to bacteria. Therefore, the more acidic a food product is, the slower its rate of deterioration will be. Acids are natural products of citrus, apples, tomatoes, etc. Acids can also be added. In the case of pickling, acetic acid may be added. Lactic acid is the product of bacteria that is native or has been added in fermentation. Microorganisms prefer an environment with a pH range of 2.0-8.0. Bacteria favor a neutral pH, molds prefer 2.0-8.0, and yeasts prefer 4.0-4.5.

Relationship Between Water, Salt, Sugar, and Osmotic Pressure

Water is required by all microorganisms. A reduction in the amount of water available is an effective means of food preservation. All of the moisture in a food product may not be available to the microorganisms. The amount of water that is available is called water activity (Aw). When salt or sugar is added to food, the Aw decreases. This is the principle used for salt or sugar-curing meat and also for syrup, jelly, and jam making. The addition of salt or sugar increases the osmotic pressure of the food item. Osmotic pressure is defined as the force that a dissolved substance (e.g., salt or sugar) places on a semipermeable membrane through which it cannot penetrate when the dissolved substance is separated from pure water by that membrane. When the osmotic pressure in a food product is high enough to draw water away from a microbial cell or prevent normal diffusion of water into the microbial cell, the cytoplasm of that cell dehydrates. This is fatal to that microbe. The greater the salt or sugar concentration is, the higher the osmotic pressure will be. A 70 percent sucrose solution will stop the growth of all food microbes.

Microbial Activity

Microbial activity affects food preservation both physically and chemically. Physical changes of food are more apparent than chemical changes. Slime formation, undesirable odors and flavors, and color changes are all physical changes caused by aerobic bacteria and yeasts. Aerobic means in the presence of O_2. Another physical change caused by aerobic molds is a sticky surface.

Chemical changes in food caused by microbial activity include the breakdown of complex organic molecules into simpler molecules. Examples include protein decomposition into peptides and amino acids under aerobic conditions. When anaerobic (without the presence of O_2) conditions are present, proteins are degraded into foul-smelling sulfur compounds. Non-protein nitrogen is degraded into ammonia. Microbes secrete lipases which hydrolyze, i.e., break down by adding water (H_2O), molecules of triglycerides into glycerol and fatty acids. Similarly, phospholipases hydrolyze phospholipids. This process creates a rancid flavor in food. Carbohydrates, the preferred energy source of microorganisms, are broken into organic acids, alcohol, CO_2 and H_2O, depending on the pathway the microorganism uses in metabolizing them. Lactic acid in fermented sausage is an example of an organic acid. Microorganisms, after degrading complex molecules, utilize the simpler molecules as nutrient sources for their growth and activity.

Chemical Preservatives

Chemical preservatives are substances added to a food intentionally to improve its appearance, flavor, texture, or storage properties. They are often called additives. One example of an additive is sodium benzoate, which is used to prevent microbial growth in soft drinks and acidic foods. Calcium and sodium propionates are additives used in breads and cakes to prevent mold growth. Cheese products may have sorbic acid added to control mold. Fruits and vegetables may be washed in a germicidal chlorine compound. Ethylene oxide and ethylene formate are fumigants used to control microbes of spices, nuts, and dried fruits. Sulfur dioxide (SO_2), is an additive which controls the browning of fruits and vegetables.

Many foods which contain fat become rancid by oxidation. Therefore, BHA (butylated hydroxyanisole), BHT (butylated hydroxytoluene), and TBQH (tertiary butylated hydroquinone) are used in products like potato chips to prevent oxidation. Nitrites are often used in cured meats to help prevent outgrowth of *Clostridium botulinum*. Salt or sugar used to lower the Aw and acid needed to lower the pH are considered additives. The addition of smoke, another additive, acts as a bacteriostat or bactericide.

Atmosphere Affects Food Perishability

Food perishability is affected by the gaseous atmosphere. In the absence of O_2, all molds and aerobic bacteria are controlled. Nitrogen is used in immersion freezing. Nitrous oxide is a propellant used in aerosol food cans. Carbon dioxide (CO_2) replaces the O_2 in fermented products. CO_2 is also used in soft drinks where it contributes to carbonic acid production. CO_2

and ozone (O_3), have been used in the holds of ships to prevent aerobic microbial growth. Ethylene gas speeds the ripening and color development in citrus and bananas. Eggs are stored in enriched CO_2 storehouses to minimize micro growth. The relative humidity levels in the gaseous atmosphere also affect the rate of spoilage of foods.

Summary

The deterioration rate of food is influenced by the type of product, pH, water activity, temperature, oxygen level, and many physical and chemical characteristics. The more acidic a food product, the slower the deterioration rate. The addition of salt or sugar to food will increase the osmotic pressure and lower the water activity, and hence the deterioration rate decreases. Microbial activity causes both physical and chemical changes in food. For this reason, food additives are often used to intentionally improve a food's storage properties. A wide variety of gaseous atmospheres can be used to help preserve food products.

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Lesson 1:
Procedures Used in Processing Food

The food processing industry has made an impact on people's lives. It is nearly impossible to eat a meal containing a food that has not been processed. Consumer buying habits help determine what food products will be processed and marketed. Can you name the processed food(s) that were a part of your last meal? What processing techniques helped transfer this food from the farm product to you?

Why Are Foods Processed?

Food processing can be defined as any mechanical, chemical, or biological treatment to food. These processes may preserve the food or change the raw material's appearance or flavor. Food is processed for many reasons. Many processed foods can be stored for longer periods of time than raw food products. Natural deterioration along with microbial growth and activity are slowed due to food processing.

Another reason for processing food is to control a food's composition. If a food product, (e.g., oatmeal) is to have a standard protein, fat, and moisture content, it must be processed. Other reasons for food processing are for convenience, variety, flavor enhancement, and value adding. Producers grow potatoes, not potato chips. Farmers harvest wheat, not flour. Most American consumers prefer to buy frozen cut up chicken pieces, not a live bird. Without flavor enhancement, most ice cream flavors would not exist. Value adding refers to techniques used to increase the economic return or worth of food.

How Can Foods Be Processed?

Foods may be processed in many different ways. The method used depends on the raw product, its destination, consumer demand, health, and safety.

Dehydration - In dehydration, the moisture is removed from a food. Dried fruit, raisins for example, and jerky are common dehydrated, processed foods.

Fermentation - Fermentation uses selected microorganisms to break down carbohydrates which releases nutrients located in plant cells. Starch in plant cells can be broken down into simple sugars. Other nutrients can be released during this process. Fermentation processes produce pickles, sauerkraut, vanilla, salami, sour cream, yogurt, cottage cheese, cocoa, beer, wine, soy sauce, and bread, just to name a few.

Milling - Milling involves the washing of grain and the removal of chaff, foreign seeds, and soil. Grains may also be separated by size using a series of sieves.

Fractionation - Fractionation is the process of separating the hulls, germ, bran, and endosperm. Particle size and density are physical properties on which separation methods depend.

Grinding - Grinding usually follows milling and fractionation. Here the particle size of grains are reduced to that of flour or meal using rollers to crush the larger particles. Wholesale cuts of meat are ground into ground beef, ground pork, etc. The term comminution refers to grinding meat.

Emulsifying - Certain food products contain both water and oils or fats. Naturally, these two constituents repel each other and separate. Emulsifiers are materials that keep this separation from occurring. For example mayonnaise contains lecithin (a phospholipid of the egg yolk) which keeps mayonnaise from separating into layers of water and oil. Margarine, salad dressing, sausage products, and ice cream are processed with emulsifiers.

Homogenizing - Homogenizing food refers to a process of forcing the food through a small valve under high pressure to reduce the size of the globules of fat. When the large globules are reduced to a small size, the food's consistency remains constant. Milk is homogenized to keep the milk fat in suspension.

Hydrogenation - This is the process of converting vegetable oil (a liquid) to a solid shortening or spread. By chemical means, hydrogen is added to an oil and the hydrogen saturates the oil's fatty acids. The newly formed product is spreadable and resists rancidity better than the oil. Margarine is an example.

Combination - Combination is mixing constituents together. Enriching bread with vitamins is an example of a combination process. Adding chocolate to milk is another example of mixing, or combining ingredients.

Texturization - Texturization refers to processes that change the shape or color of a food. Durum wheat is processed, or texturized, into macaroni or spaghetti. Meat may be flaked, ground, or chopped and then reformed into a steak or roast-like product. These are called restructured meats.

Chemical Modification - The addition of heat, enzymes, or microbes is a process called chemical modification. Popcorn in its popped state, corn syrup, and pickles are examples.

Precipitating/Centrifuging - To precipitate means to separate a solid from a solution. Centrifuging is a quick means of separating constituents with different densities. Separating cream from milk is a common example of separation based on densities. Wet corn milling involves a procedure in which the germ floats in the settling trough and is skimmed off. The starch, protein, and hulls are then screened to remove the hulls. The starch and protein solution is then centrifuged and the denser starch particles are thus separated.

Extrusion - Extrusion is a process where a formulated dough or mash is forced through an extruder under high pressure. High pressure causes the starch molecules to swell and then gel. The steam generated by the heat of the process causes a puffing of the product which forms a new shape. Breakfast cereals are commonly extruded.

Food Safety Assured

Food safety depends on a number of factors and the activities of many people. Both the federal and state governments are responsible for food safety until the consumer purchases the food. An estimated $1 billion is spent annually by 12 federal agencies to ensure food safety and quality inspection. Private and state agencies spend more than $5 billion annually.

The Federal Meat Inspection Act of 1906 still provides mandatory inspection of animals, slaughtering conditions, and meat processing facilities. It regulates interstate meat sales.

In 1967, the Wholesome Meat Act was passed. It requires all state and city meat regulations to meet federal standards. The Federal Poultry Products Inspection Act of 1957 and the Wholesome Poultry Products Act of 1968 set federal standards on poultry.

The public is protected against false advertising in the food industry due to the Federal Trade Commission Act of 1938. The Food, Drug, and Cosmetic Act of 1938 set the basic principles of food safety and gave the FDA the power to enforce food safety measures. Infant formulas must contain the known essential nutrients at the appropriate levels according to the Infant Formula Act of 1980. Federal Grade Standards maintain uniform quality standards. State and Local laws are usually administered by the Health Department.

The Food and Drug Administration (FDA) assures consumers that the food they buy is safe, nutritious, and honestly represented. All additives must be approved by the FDA before use. The FDA also has a Generally Recognized As Safe (GRAS) list of over 600 ingredients (e.g., sugar, table salt, cinnamon) that are not considered additives. It is the USDA's job to monitor for safety and quality all meat and poultry. The FDA monitors all other processed foods. The Grade A Pasteurized Milk Ordinance established minimum quality standards for Grade A milk.

America's food is arguably the world's safest and most wholesome. Yet several million people suffer from food-related illnesses each year. A large number of these illnesses (70-80 percent) can be prevented by proper food handling at home and in restaurants.

Cleaning and Sanitization

Most equipment in food processing plants is constructed of stainless steel. Not only is stainless steel durable, but it can be easily cleaned and sanitized. Cleaning refers to removing all visible filth. Sanitizing means destroying any microbial contaminants. Food contact surfaces are usually rinsed with tap water to remove most of the food residue before cleaning starts. An alkaline cleaner in hot water is the normal cleaning solution. Its strength and temperature depend on the type of soil to be removed and whether washing is by hand or by mechanical circulation. This step is often followed by washing with an acidic solution thus dissolving residues of minerals. Following cleaning, sanitizing is performed with 180°F water or an approved chlorine or iodine rinse. Metal equipment, other than stainless steel, may need an edible mineral oil coating to prevent it from oxidizing (rusting).

Summary

Food processing is an important part of the food industry. Any mechanical, chemical, or enzymatic treatment to food which alters its original form is called food processing. Length of storage, slower deterioration, anti-microbial contamination, convenience, composition control, and flavor are some of the reasons for processing.

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Lesson 2:
Food Product Development

The Big Mac, tater tots, catsup in a squeezable bottle, and microwavable TV dinners were all once just ideas. Today these are common foods. People expect new food products to provide good taste and good nutrition and be easy to prepare. Many food scientists are called product developers. Their jobs are to take good ideas and turn them into reality.

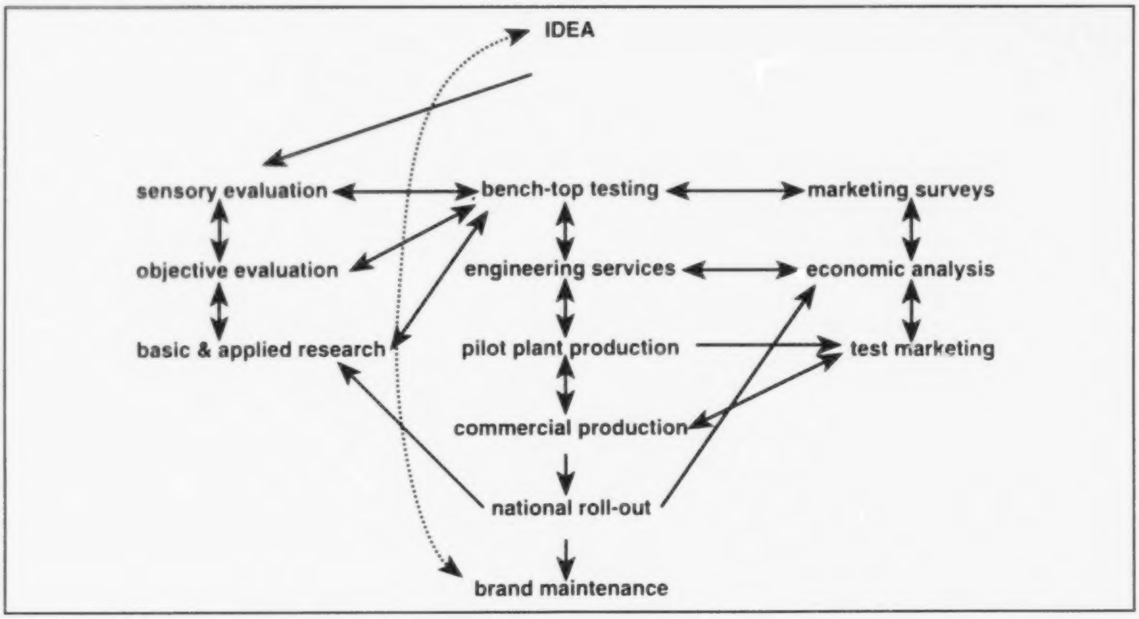
New Food Products

Research in food science is a continual process. Reports of new ingredients, processes, and preservation techniques fill the pages of many journals every month. Product development scientists study these advances with an interest to use them to make new and different food products. Changes in nutritional information and new keys to the role of diet and health also provide impetus to scientists trying to provide foods that consumers want. It is a complex and difficult task. The success rate for new food products is less than 0.1 percent, measured as products that make it to national market for longer than three years.

Where do new food product ideas come from? Often consumer complaints about an existing product to sales staff result in significant changes in food products. Other times the sales staff themselves will see a market they could fill, if only there was a product that did what the customer wanted. Sometimes old products can be reintroduced to the market, capitalizing on nostalgia, often coupled with new ways to make the product more convenient to prepare. Even laboratory mistakes may become successful products, if the scientists are creative enough to see an application. Most new products are called "line extensions." These are products created by making small changes in existing products, like putting fruit color and flavors into a plain corn puff breakfast cereal and marketing it to children. Similarly, a successful product introduction by one food company may result in the introduction of many "me-too" products by their competitors. However they happen, every new food product begins with an idea.

Where the idea goes next is a complex series of steps that do not always follow in any particular order (Figure 2.1). Nevertheless, all these elements will be part of the process in one form or another. Bench-top development is the production of prototypes of new products on a

Figure 2.1 - Development Process



small scale. These laboratories often look like very large kitchens, but if you were to spend some time there you would find many specialized instruments not found in most home kitchens.

Objective testing involves discovering if the idea can be produced to have enough shelf-life and safety to allow successful marketing. Sensory evaluation is required to find out if consumers like the taste, color, and other characteristics of the product. Often objective testing and sensory evaluation require basic and applied research to solve specific problems uncovered in their studies. Pilot plant production evaluates the production processes using equipment that is very much like miniature equipment used in the production facility. Usually engineering services are required to modify existing processing facilities, or to design new ones to fit the specific requirements of the new product. Marketing surveys may be employed to refine the product to meet the desires of specific consumers. Economic analysis is needed to learn the costs of the product, and if the new product will make a profit for the company. Each of these pieces of the product development puzzle must be fit together in order for the product to be successful in the highly competitive food market.

Finally, a new product is born. At this point there may be as many as three years of effort by several different groups of researchers invested in the product. But the job is not over yet. Test marketing will be required to figure out if consumers will really buy the product when they see it on store shelves or on restaurant menus. National roll-outs are the ultimate test of a new food product. The national roll-out of a product occurs when a company makes a commitment to sell the product throughout their marketing system. Usually these national roll-outs are accompanied by complex, carefully orchestrated advertising campaigns. Even at this point the process is not complete. Careful brand maintenance is required to make sure the product performs the way the consumer expects. Careful evaluation of sales figures, consumer comments and complaints, and good market analysis help to prevent a product from failing. Adjusting a product to meet changing market demands may require new product development, and so the process begins again.

A Good Example: Margarine

During World War I, there was a shortage of butter available to consumers living in the U.S. Most of the nation's butter was being served to the military men and women who "deserved nothing but the best." Those people left to support the war effort stateside were without this very commonly used food ingredient. There was a need for a new product.

Butter is a complex food that consists of water, oil, protein, and several other components. The oil and water mixture is stabilized into an emulsion, so that the two layers do not separate as they often do in a homemade salad dressing. Stabilization requires the presence of an emulsifier. Emulsifiers can dissolve in both oil and water, creating micelles. These micelles can be made small enough that the natural tendency of oil and water to separate can be overcome. In butter, proteins and glyceride molecules serve as the natural emulsifiers, preventing the emulsion breakdown. The goal of the product developer was to simulate this food using ingredients that were readily available, even during wartime.

The soybean provides almost all of the ingredients used in the production of margarine. Soybean oil serves as the lipid source and lecithin, a natural product extracted from the soy oil, is the principal emulsifier. The fatty acids in soybeans are very different from those found in milk, so a process known as hydrogenation was employed to change the melting point of the soybean lipids. Hydrogenation adds hydrogen atoms to the unsaturated double bonds on the fatty acids. As the fatty acids become more saturated (with hydrogen atoms) their melting point increases. By careful control of the amount of hydrogenation used, soybean oil can be made to melt very much like butter. The next step was to get the oil and water emulsion to form. By blending hydrogenated oil, water, and lecithin together in something very similar to a blender, the desired emulsion could be formed.

Unfortunately, the resulting product looked (and tasted) very much like vegetable oil shortening. By adding various colors, flavors and vitamins, margarine began to be a reasonable substitute for butter. In the early days, it was very easy to tell the difference, but as margarine development continued the product became more like butter all of the time. Since it was made from very inexpensive ingredients, and these ingredients were more consistent in composition than milk, margarine could be produced at a much lower cost than butter, contributing to its popularity. Because margarine is a completely formulated product, it is easy to make changes like "low-fat" margarine, flavored margarines and squeezable margarine, just to name a few.

Summary

Food product development is a complex process involving many different people. However, the product always begins with an idea, which may have come from a consumer, a breakthrough in basic science, or just a mistake in the laboratory. Lots of creativity and hard work are necessary to get a food product to a national market.

Margarine is a good example of a product invented to meet a need. Margarine is a completely formulated product, replacing most of the dairy components with ingredients derived from soybeans. It is easier and cheaper to produce than butter. Many other new products have been developed from margarine because of its unique properties.

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Lesson 3: Milk Processing

Quality Grades

In most states, milk is classified as Grade A raw milk, manufacturing grade, or reject. Some areas of the country classify milk as Grade A and B or C. Grade A milk must be produced in facilities that meet high standards of sanitation defined by the state health department. Grade A milk is either raw or pasteurized and is intended for fluid milk consumption or in some places for ice cream. The standard plate count of aerobic microorganisms must not exceed 100,000 or 20,000 per ml of raw or pasteurized milk, respectively. It must be pasteurized, come from a sanitary dairy, and be cooled to below 40°F. Milk producers and their milk quality are closely monitored by inspectors.

Manufacturing grade, or in some states Grade B or C, milk is produced under less stringent conditions and is used to make cheeses, butter, and dried milk.

Reject milk does not meet minimum standards for human consumption. If rejected, no grade is assigned. Milk is not easily moved from grade to grade because facilities and practices differ.

Major Milk Products

Raw milk can be processed into fluid milk, fermented milks, cream, butter, canned milks, dried milks, cheeses, and ice cream.

Fluid milk can be whole milk, low-fat milk, nonfat milk (skim milk), and chocolate milk. Fluid milk must be made from Grade A milk only. Whole milk contains at least 3.25 percent fat. Low-fat milk can be 2 percent, 1.5 percent, 1 percent, or 0.5 percent fat. Nonfat milk contains less than 0.5 percent fat. Chocolate milk is a major product of fluid milk and may be made in any of the fat percentages listed above. Chocolate milk has liquid chocolate or cocoa and sugar added.

Any fluid milk product can be made from milk, low-fat milk, or nonfat milk and must be so labeled. For example, cultured buttermilk is made from milk (at least 3.25 percent milk fat), low-fat milk (0.5 to 2 percent milk fat), or nonfat milk (less than 0.5 percent milk fat).

Fermented milks or those that have been cultured with specific bacteria include cultured buttermilk, yogurt, and acidophilus milk. Fermented milk must be made from Grade A milk. Cultured buttermilk is skim, low-fat or whole milk that has been pasteurized, inoculated with a lactic acid-producing bacterium, and held at 72°F. Yogurt is fermented whole, low-fat or skim milk. It is fermented by *Streptococcus thermophilous* and *Lactobacillus bulgaricus*. These microorganisms convert lactose to lactic acid which reduces the pH. The lowered pH reduces the solubility of casein which results in the characteristic coagulum.

Acidophilus milk is a product designed for consumers who are lactose intolerant. Much of the lactose in milk is digested by the *Lactobacillus acidophilus* bacterium; furthermore, this bacterium is able to stick to and live in the human intestine.

Creams consist of cream, half-and-half, coffee cream, whipping cream, heavy whipping cream, and sour cream. Creams must be made from Grade A milk only. Cream consists of 18 percent milk fat. Half-and-half consists of equal parts of whole milk and cream. Cream contains 18 percent and milk contains 3.25 percent milk fat, so combining them in a 1:1 ratio produces half-and-half testing [(18+3.25) ÷ 2 = 10.625 percent fat]. This number is rounded to the nearest 0.5 percent for regulatory purposes. Whipping cream and heavy whipping cream contain at least 30 percent and 36 percent milk fat, respectively. Sour cream is pasteurized cream that has been inoculated with a lactic acid-forming and flavor-producing bacteria and incubated for a controlled length of time.

Butter is a water-in-oil emulsion made by churning cream.

Canned milks have reduced water content due to evaporation. The two types of canned milk are evaporated milk and sweetened condensed milk. Evaporated milk has had 60 percent of the water removed. The resulting product is 7.5 percent milk fat and at least 25 percent milk solids. In comparison, whole milk is 3.25 percent milk fat and 12-14 percent milk solids. The evaporated milk is homogenized before being placed in a can and is then sterilized. When evaporated milk is sterilized, the casein-whey protein complex tends to gel. The additive carrageenan is used to promote a smooth texture.

Sweetened condensed milk also has had more than half of its water removed. It differs from evaporated milk in that sucrose or glucose has been added. The added sugar serves as an antimicrobial agent, increases the viscosity of the milk, and promotes browning during heating. It also contributes toward a grainy texture. The caramel flavor is a result of heating the sweetened condensed milk during processing. Many desserts contain sweetened condensed milk.

Another major milk product is dried milk. The water content is reduced until the milk is a powder that can be stored in airtight containers at a cool temperature for long periods of time. Dried milk is usually nonfat dried milk. Nonfat dry milk is a major product made from skim milk. Much of the cream separated to make skim milk is used to make butter.

Cheese is made from pasteurized milk that has been inoculated with lactic acid-producing microorganisms (i.e. *Lactococcus lactis*). The milk sugar (lactose) is converted to lactic acid which reduces the pH from 6.7 to 4.6. At this isoelectric point, casein clabbers (forms a soft curd). The curd is then cut, which releases the whey from the gel. To make coagulum with a higher pH the enzyme rennin is then added to the milk. Rennet splits the casein molecule into a hydrophilic glycopeptide and a hydrophobic molecule. The hydrophilic glycopeptide is removed and curd develops. The curd is cut and cooked to remove whey; then it is salted, shaped, and ripened.

A variety of textures, odors, and flavors result from ripening. Flavors result from chemical changes in the fats and proteins. Microorganisms are often added to promote these chemical changes. An example of this is in the production of Roquefort cheese. A blue mold, *Penicillium roquefortii*, is added to split certain fat molecules. Processed cheese is a combination of fresh and ripened natural cheeses with an emulsifier. The mixture is worked and cooked. Most processed cheese has a moisture level around 41 percent. Processed cheese spread has about a 45 percent moisture level.

Ice cream is a major milk product. It is a frozen mixture of cream, nonfat milk solids, sweeteners and flavorings into which air has been stirred. Ice cream must contain 10 percent milk fat, 20 percent milk solids, and no more than 0.5 percent stabilizer and 0.2 percent emulsifier. When sugar is added, the freezing and melting points decrease. Frozen custard is made by the addition of egg yolk solids to the ice cream mixture before freezing. Ice cream is labeled with descriptors when it contains less than 10 percent milk fat. These and their milk fat contents are as follows: reduced fat, 7.5 percent; light, 50 percent less fat; low fat, 3 grams of fat; fat free, less than .5 grams of fat. Sherbet contains 2-5 percent milk solids and 1-2 percent fat. In imitation ice creams part or all of the milk components are replaced with nondairy ingredients.

Milk By-Products

As raw milk is processed into a variety of major products, there are some by-products that result which are quite useful. Buttermilk is the fluid removed from churning cream into butter. Most of it is dried for use in the baking industry. A by-product of cheese making, whey, is a liquid containing lactose, serum proteins, minerals, and vitamins. It is an important component in certain livestock feeds, but much of it is being used in human food today. Whey protein concentrate and isolate are two major forms of whey used in foods.

Taste and Composition Factors

The taste of milk and its composition are directly related to production, handling, processing practices, and breeding. Milk may be adulterated by several different factors. Antibiotics can inhibit the growth of bacterial cultures.

Pesticides and radionuclides don't affect milk taste and only minutely change composition. Pesticides in milk can be detected by qualitative and quantitative analysis using chromatography. Radionuclides may contaminate milk but this

Table 3.1 - Typical Composition of the Milks of Cows

Breed	Percent in Milk				
	Water	Fat	Protein	Lactose	Ash
Guernsey	85.35	5.05	3.90	4.96	0.74
Jersey	85.47	5.05	3.78	5.00	0.70
Ayrshire	86.97	4.03	3.51	4.81	0.68
Brown Swiss	86.87	3.85	3.48	5.08	0.72
Shorthorn	87.43	3.63	3.32	4.89	0.73
Holstein	87.72	3.41	3.32	4.87	0.68

usually occurs only when tests of nuclear weapons are done above ground or when an accident at a nuclear reactor releases radioactive elements. Examples of the contaminates include iodine 131, strontium 90, and barium 140.

A high somatic cell (white blood cells) count, points towards an infection in the cows udder, probably mastitis. The California Mastitis Test is used to detect high somatic cell counts in milk taken directly from the cow. A freezing point test checks for added water. Foreign material, or sediment, may contaminate the milk via the cow, equipment, or environment. A sediment test is conducted on raw milk to determine the amount of sediment.

Flavor is influenced by the age of the milk, the facilities used to process it, the temperature of the milk and rate of cooling, and certain offensive feeds in the cow's diet. The amount of milk fat also changes the milk's flavor and consistency. Facilities are unlikely to affect flavor or composition in today's milking operations.

The species and breed of animal makes a difference in milk's taste and composition. (Table 3.1). There is also a range of difference based on the animals' age, stage of lactation, season of year, feed, time of milking, physiological condition of cow (i.e. calm or excited), and length of time between milkings.

The greatest single factor governing the composition of milk is the breed of cow from which it was produced.

Summary

Milk is quality graded based on the facilities of the producer, its bacteria and somatic cell counts, and care taken in production and processing. Milk is graded as grade A, manufacturing grade, or reject milk. The quality grade determines eligibility for use in fluid products. Milk can be processed into fluid milk, fermented milks, creams, butter, canned milks, dried milks, cheeses, and ice cream. Buttermilk and whey are important milk processing by-products. The taste and composition of milk is determined by several factors. The most important factor in composition is the breed of cow from which the milk was produced.

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Lesson 4: Processing Dairy Products

Dairy products play an important role in the human diet. This lesson discusses the techniques used to process raw milk into a variety of products that can be found in the dairy case at the grocery store.

Processing Raw Milk

The milk jug in your refrigerator probably contains milk from several cows. That is a result of modern processing techniques. Quality control tests are the first techniques used in processing raw milk. These tests include determination of fat and solids contents, sediment content, bacterial counts, freezing point, and milk flavor. All raw milk received at a processing plant is tested for antibiotics before the milk is pumped from the delivery truck.

The second step is separation, the process of removing fat from milk in the form of cream. Separation with a continuous centrifuge produces about 10 pounds of cream testing about 36 percent fat and 90 pounds of skim milk from each 100 pounds of milk.

The third step is standardization. Batches of milk and skim milk or cream are blended in large tanks to reach a uniform fat content. Clarification is the fourth step. Here the milk is centrifuged to remove sediment, body cells, and some bacteria.

Pasteurization is the next step aimed specifically at eliminating any disease-producing microorganism. Heating milk to 161°F for 15 seconds meets minimum pasteurization criteria. Louis Pasteur is credited with designing this technique but he did so with wine. Pasteurization effectively destroys the tuberculosis bacterium.

Modern food science helped develop step six, which is homogenization. Fat globules in fluid milk naturally clump together and rise to the top. Homogenization subdivides the fat globules so they will no longer separate and rise to the top.

In the United States, fluid milk is generally fortified with vitamin D. This is step seven. Following fortification, the milk is cooled and finally packaged.

Why Pasteurization and Homogenization?

In 1871 Louis Pasteur proved that heating to a critical temperature destroyed the spoilage microbes in a liquid. Other scientists have shown what the temperature must be for different lengths of time in order to kill specific disease-producing (pathogenic) bacteria and viruses in milk and its products. The milk industry applies the concept to milk processing. Pasteurization is necessary to rid milk of any disease-producing microorganism and to reduce the total bacterial numbers for improved shelf life. Lipase and other natural enzymes are destroyed by this process which proved to be the breakthrough in preventing the spread of tuberculosis. The batch method is designed to heat each milk particle to 145°F for 30 minutes. The high temperature, short-time method (HTST) heats every particle to at least 161°F for 15 seconds. The HTST method has largely replaced the batch method. Pasteurized milk is not sterile, so it must be refrigerated.

Homogenization is the reason why every glass of milk from a milk jug is consistent in flavor and texture. In the homogenization process, milk is pressure pumped to subdivide its fat globules. The fat globules are divided into very small globules and this prevents them from rising to the top and forming a cream layer. Milk that has undergone homogenization, which is not necessary for health reasons, is richer in taste and whiter in appearance than unhomogenized milk.

Processing Major Dairy Products

The milk processing industry stands as one of the largest segments in the food science area. A growing number of products result from research efforts in this field. Fifteen major products are discussed in this lesson.

Whole milk has a minimum milk fat level of 3.25 percent. It is pasteurized, homogenized, fortified with vitamin D, and packaged. Vitamin D is added because the diets of many children in the U.S. are deficient in Vitamin D.

Low-fat milk has its milk fat level standardized to 0.5 percent, 1 percent, 1.5 percent, or 2 percent, and is fortified with vitamins A & D, pasteurized, homogenized, and packaged. Vitamins A and D are fat-soluble vitamins. This means that as the milk fat is removed, so are these vitamins. Therefore, low fat milk must be fortified with them.

Non-fat milk (also called skim milk) has its milk fat level reduced to below 0.5 percent, is fortified with vitamins A & D, and is pasteurized, homogenized, and packaged.

Chocolate milk can be made from whole, low-fat, or nonfat milk that is mixed with chocolate syrup or cocoa powder and sugar.

Cultured buttermilk is skim, low-fat, or whole milk that is heated to 185°F for 30 minutes and then inoculated with lactic acid-producing bacteria and held at 72°F until the pH drops to about 4.5. Then it is cooled. This controlled environment allows the pH, flavor, and texture to be modified.

Yogurt is another product that can be made when appropriate microorganisms are allowed to ferment at about 110°F. *Streptococcus thermophilous*, and *Lactobacillus bulgaricus* are used to inoculate whole, low-fat or skim milk. The pH is lowered as lactose is converted to lactic acid, and casein (milk protein) coagulates and forms the thick texture of yogurt.

Acidophilus milk is fermented whole milk. Milk is fermented by adding *Lactobacillus acidophilus* bacteria. These bacteria digest the lactose in the milk, making it possible for lactose-intolerant people to drink this milk. Sweet acidophilus milk contains the same bacteria but is not fermented.

Cream (high in milk fat) is separated from the raw milk with a centrifuge. After it rises to the top, it is skimmed off (Quiescent method). It is then pasteurized and processed into a variety of fat-content creams, such as whipping cream, coffee cream, half-and-half, sour cream, or heavy whipping cream.

Sour cream, as previously mentioned, begins as cream that has been separated from raw milk. This cream is pasteurized and cultured with lactic acid-producing and flavor-producing bacteria. Sour cream is 18 percent fat whereas half-and-half is 10.5 percent fat.

Butter is produced by churning (agitating) sweet or sour cream. In the U.S., sweet cream is the preferred type. The cream must be churned sufficiently to break the oil-in-water emulsion of cream and form a water-in-oil emulsion. The butter is washed with cold water and then worked to reduce the water content to around 15 percent. Butter is at least 80 percent fat. Salt may be added to enhance the flavor and color may be added to reach the desired yellow color.

Canned milk has had 60 percent of the water evaporated before it is homogenized. The concentrated milk is at least 7.5 percent milk fat and 25 percent milk solids. This viscous milk is canned and sterilized at 240°F for 15 minutes. An additive, carrageenan gum, is used to give it a smooth texture. Sweetened, condensed milk is canned with sugar added.

Nonfat dried milk is skim milk that has been dehydrated so that it can be stored for long periods of time at room temperature. Growth of microbes is prevented due to the low moisture content. It may be reconstituted before use or used in the dried state. Instant nonfat dry milk has been wetted and redried to increase its ability to be dispersed and dissolved in water.

Ice cream is a frozen mixture of cream, milk solids, sugar, and flavorings into which air is stirred as the mixture is frozen. Ice cream is 10 percent milk fat which accounts for its smoothness of texture and richness of flavor. The milk is heated to 140°F and then sugar, an emulsifier, a stabilizer, and flavorings are added. This mixture is pasteurized, homogenized, and slightly aged. Then it is frozen to 20°F while air is whipped into the cream. It is now ready for packaging. Frozen custard differs in that egg yolks are added to the mixture. New labeling will replace ice milk with reduced fat, light, low-fat, and nonfat ice creams. Sherbet has 1-2 percent milk fat and only 2-5 percent total milk solids.

Natural cheese is made from pasteurized milk that has the added enzyme rennin, which helps clot the milk. Bacteria convert lactose to lactic acid and the pH drops from 6.7 to as low as 4.6. A soft curd develops. This curd is cut to release the whey, which is a watery liquid that contains lactose, serum proteins, minerals, and water-soluble B vitamins. The riboflavin in it gives it the yellow-green color. The curd is then heated, pressed down to 40 percent water, salted, shaped, and ripened. Ripening alters the texture, odor, and flavor. Two of several cheeses that are not ripened are cottage cheese and cream cheese.

Processed cheese is a mixture of different kinds of natural cheeses that have been mixed and ground together and then melted to a uniform product with the aid of emulsifiers. Processed cheeses contain about 1 percent more moisture than the natural cheese from which they are made, which forms an easier spreading product. Additional moisture is permitted in processed cheese food and even more in processed cheese spread.

Packaging

Milk and dairy products should be packaged for protection and convenience. A fundamental reason for packaging is that mold and bacterial contamination are prevented with proper packaging. Shelf-life and freshness increase with a sealed package. Riboflavin (vitamin B_2), thiamine, vitamin A, and vitamin C in fluid milk are light sensitive. Opaque or other appropriate packaging is useful in reducing the breakdown of these vitamins when containers are exposed to sunlight or ultraviolet light. Dried whole milk is packaged under nitrogen, so the packaging material must be impermeable to oxygen.

Industry Organization

Today's dairy industry is composed largely of individual producers who belong to milk cooperatives. The cooperative pools the milk and processes it or sells it to proprietary (private) processors. Separate processing plants for cheese and ice cream production are the norm. Coops generally belong to the National Milk Producers Federation whereas processing firms belong to the International Dairy Foods Association (IDFA). These organizations conduct research and do educational, promotional, regulatory, legislative, and training activities for their members as well as the general public. California, Wisconsin, New York, Pennsylvania, and Minnesota rank as the top five milk producing states.

Summary

Milk is nature's most complete food nutritionally. It is rich in calcium, phosphorus, water-soluble vitamins, protein, and carbohydrates. Before it arrives at the grocery store, milk is tested, standardized, clarified, pasteurized, homogenized, fortified, cooled, and packaged. Pasteurization rids milk of pathogens, and homogenization improves its drinking quality. Milk is processed into numerous products using multiple techniques. Milk products are fresher and store longer if they are properly packaged. The dairy industry is composed of individuals, cooperatives, and national organizations that work toward providing quality dairy products for American consumers.

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Lesson 5: Processing Egg Products

Eggs are one of the few foods that are popular in almost every culture. They have been a part of the human diet since the dawn of recorded history. In the United States, eggs play an important role in breakfast and baking and are responsible for employment of thousands of people. The consumption of eggs in the U.S. has declined since 1951, when the average person consumed 387 eggs a year.

Egg Products

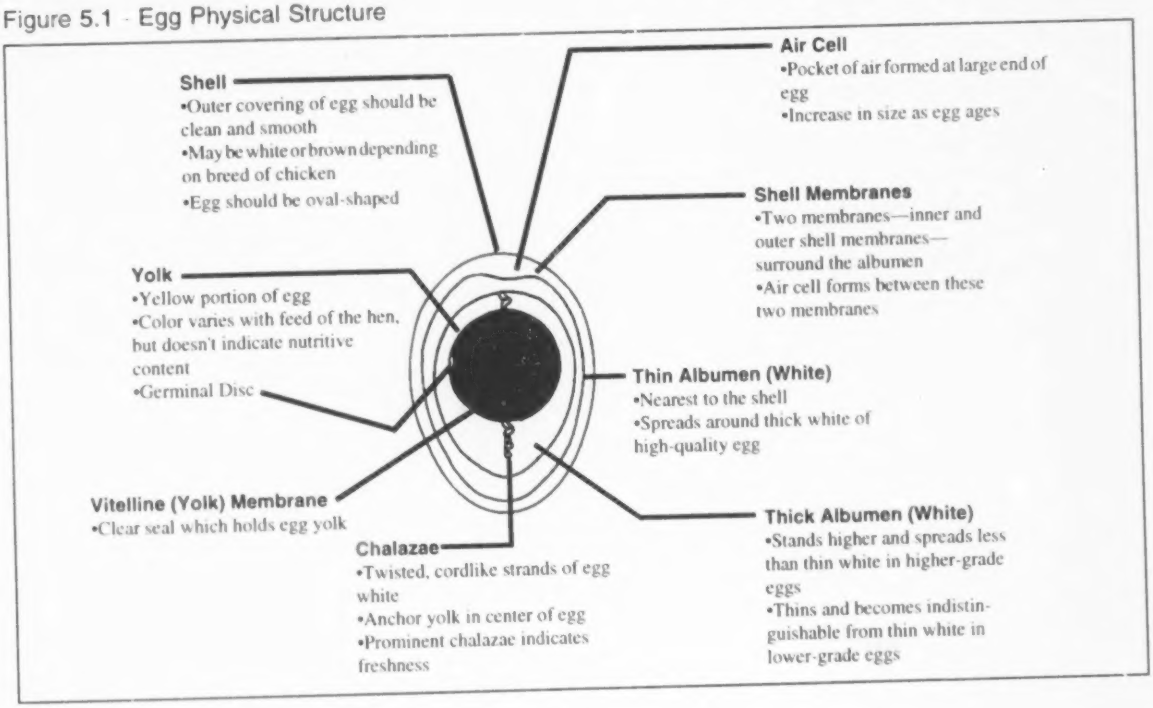
Eggs are useful in a variety of ways. About 80 percent of all eggs produced are retailed as shell eggs. Another egg product is refrigerated liquid eggs. These eggs are broken, and separated if necessary, by machines. The liquid product is usually pasteurized to kill Salmonella and other microorganisms prior to being packaged. They may be shipped to bakeries or to other plants for further processing. Under refrigerated conditions, 40°F or below, liquid eggs have a shelf life of 10 days. Liquid egg may be frozen for greater shelf life. Egg blends with sugar, corn syrup, or salt added are available for special uses. Another egg product is dried eggs. These may also be called egg solids. World War II created a huge demand for dried eggs. Current demand for dried eggs comes from production of convenience foods as well as the food service industry. Specialty products include pre-peeled hard-boiled eggs, frozen omelets, egg patties, and quiches.

Quality Characteristics

Egg quality is based on exterior and interior characteristics. The egg's exterior, or shell, should be clean and have a smooth texture. The shell is checked for soundness (i.e., the presence of any cracks). The egg should be oval-shaped with one end larger than the other. Misshapen eggs are generally used for the production of liquid egg products.

The interior quality of an egg is determined by candling. Candling allows the grader to look inside the egg without breaking it. Years ago this was done by holding the egg up to a candle, hence the name. Today, high intensity lights reveal the interior of each egg as it passes on rollers. Inspectors, sometimes called candlers, determine air cell depth, the clarity of the albumen, and the size, shape, and color of the

Figure 5.1 - Egg Physical Structure


Shell
•Outer covering of egg should be clean and smooth
•May be white or brown depending on breed of chicken
•Egg should be oval-shaped
Air Cell
•Pocket of air formed at large end of egg
•Increase in size as egg ages
Shell Membranes
•Two membranes—inner and outer shell membranes—surround the albumen
•Air cell forms between these two membranes
Yolk
•Yellow portion of egg
•Color varies with feed of the hen, but doesn't indicate nutritive content
•Germinal Disc
Thin Albumen (White)
•Nearest to the shell
•Spreads around thick white of high-quality egg
Vitelline (Yolk) Membrane
•Clear seal which holds egg yolk
Thick Albumen (White)
•Stands higher and spreads less than thin white in higher-grade eggs
•Thins and becomes indistinguishable from thin white in lower-grade eggs
Chalazae
•Twisted, cordlike strands of egg white
•Anchor yolk in center of egg
•Prominent chalazae indicates freshness

egg yolk. New machines are being invented to automate the candling process. If the egg contains a blood spot, it is revealed during candling and the egg is discarded. Figure 5.1 details the physical structure of an egg.

Another means for determining interior egg quality is the breakout method. Sample eggs are selected at random and broken out on a level surface. The height of the albumen (egg white) is measured with a micrometer. The highest quality eggs will stand up tall and have a firm yolk. Also, the surface area covered by the albumen is small in high quality eggs.

Quality Influences

Egg quality can be influenced by several factors. The equipment and method used to handle a freshly laid egg can affect internal and external qualities. Rough handling can result in shell breakage. Vibration of an egg can result in a thinner albumen or a free air cell. The type of animal housing often determines the method of handling as well as the frequency of egg collection. Proper temperature, humidity, and lighting in the facility affects egg quality.

The hen's diet is another factor that influences egg quality. Shell strength is determined by the presence of adequate amounts of vitamin D, calcium, and other minerals. A lack of vitamin A can result in blood spots. Maximum egg size requires an adequate amount of protein and essential fatty acids in the ration. Yolk color is influenced by the amount of xanthophylls, or yellow-orange plant pigments, in the diet. A ration of yellow corn and alfalfa meal will result in a yellow yolk while a wheat based ration will produce a lighter colored yolk. Often, producers will include dried marigold petals in the ration to increase the yellow color of the yolk. While important, yolk color is not the only factor considered when determining egg quality.

Egg shell thickness is an important characteristic in quality eggs. Research suggests that the greater number of eggs a hen lays, the thinner the shell. Because some breeds produce more eggs per year than others, the breed of hen influences quality. As a hen ages, her egg size increases which demands the same amount of shell material to be stretched to cover the larger egg. This results in thinner shells. The status of a hen's reproductive tract influences the formation of blood spots. Blood spots, also called meat spots, result from a ruptured vessel on the surface of the yolk during ovulation (the release of the yolk into the oviduct).

Egg quality is influenced by the age of the egg. Prompt gathering, washing, oiling, and cooling to 45°F or below are essential to maintain freshness and to prevent growth of salmonellae bacteria that may be deposited inside the egg by infected hens, a condition known as transovarian salmonella. Oiling the process where a film of odorless, tasteless mineral oil that is sprayed on shell eggs after washing and before cartoning. It replaces the natural cuticle, known as the bloom, that is removed during washing. Genetics also plays a role in egg quality; certain egg defects can be traced to specific genetic lines of hens.

Egg Grading

The Egg Products Inspection Act of 1970 provides for USDA grading of all eggs carrying the official grade shield. Based on interior and exterior quality, eggs are graded by USDA graders and are designated AA, A, or B. All eggs must be clean and have sound shells. Grade AA and A eggs must be oval shaped. Abnormal shell shape or faulty texture are permitted under B quality. The albumen is judged on the basis of clarity and firmness. Grade AA eggs when broken out stand up tall, have a firm yolk, and have a large proportion of thick albumen. Grade A eggs are medium in height, have a firm yolk, and have an albumen that begins to spread (flatten) out. Grade B eggs have a flat yolk and a thin albumen. Air cell depth ranges from 1/8 inch in AA grade to 3/16 inch in B grade eggs.

Egg Processing

Grade AA and A eggs are regularly retailed as shell eggs. Grade B eggs and surplus Grade A eggs are processed into egg products. These include refrigerated liquid, frozen, dried, and specialty products. Convenience foods such as cake and pudding mixes, pasta, mayonnaise, and bakery goods utilize egg products. The food service industry often prefers egg products to shell eggs because of convenience, uniformity, and stability. All egg products are USDA inspected and pasteurized. Pasteurized egg products are preferred because they have been treated to kill salmonellae bacteria, pathogens common in the hen and her environment.

Egg Size

Egg size is not related to quality grades. Eggs are sized based on the number of ounces per dozen. They are shown in Figure 5.2.

Figure 5.2 - Egg Size

Egg Size	Ounce per Dozen
Jumbo	30
Extra Large	27
Large	24
Medium	21
Small	18
Peewee	15

Egg Processing Industry

The egg production/processing industry in the United States is vertically integrated, which refers to the business structure in which the company that owns the processing plant may also own the feed company and the birds. Producers contract with large companies to produce the eggs, while the companies supply the birds, feed, and fuel. The producer usually provides the housing and the labor. Often the contract producer receives a graduated fee that reflects bird performance and management skills.

Egg production is the greatest in the Southeast portion of the United States. Production is also concentrated near population centers such as California and Pennsylvania.

Summary

Eggs are a wonderful source of protein and can be used to make hundreds of foods. Whether they are in the shell, liquid, frozen, salted, or sugared, eggs undergo exterior and interior inspections. Egg quality is influenced by a variety of factors ranging from the hen's diet to the facilities where the hen's lay eggs. The USDA grades eggs AA, A, and B based on interior and exterior factors. Eggs are sized according to weight per dozen. The egg production/processing industry is a vertically integrated industry.

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Lesson 6: Products and By-Products From Meat Animals

The meat processing industry is one of the largest employers in the diverse field of agriculture. This lesson examines the products and the by-products of meat processing.

Major Meat Animals

Our meat supply originates from five major meat animal species. Beef and veal are products of cattle. Pork is a product of swine. Sheep produce lamb and mutton. Poultry is from chicken or turkey. Fish and shellfish are another major meat source.

Fresh Meat Products

Fresh meat products are classified as either primal (wholesale) or subprimal (retail). Primal cuts are large regions of the carcass whereas subprimal cuts are cut to portion size, much like what you would find in the grocery store. Beef, pork, and lamb carcasses are divided into four primal cuts. They are: chuck/shoulder, rib, loin, round/ham/leg. Primal cuts of poultry consist of a whole fryer or turkey. Whole fish and fish fillets are primal cuts.

Subprimal cuts for beef, pork and lamb include shoulder/chuck blade, shoulder/chuck arm, breast, rib, leg/round, short loin, and sirloin. Figures 6.1, 6.2, 6.3, and 6.4 further detail the various subprimal cuts of beef, veal, pork, and lamb. Poultry subprimal cuts include half/quarter portions, breasts, and boneless strips. Fish may be retail cut into sticks, squares, or fillets.

Processed Meat Products

Historical evidence suggests that the Babylonians made and ate sausage some 3,500 years ago, and that the ancient Chinese also made sausage. Sausages frequently took the name of their town of origin: bologna from Bologna, Italy; frankfurters from Frankfurt, Germany; and Vienna sausage from Vienna, Austria. Immigrants to the U.S. continued to make sausage to satisfy their ethnic tastes which has led to more than 200 different varieties in America's processed meat industry.

Processed meat products are popular today due to their long shelf life, convenience, low waste, and controlled portion size. Processed meat also provides variety in the diet. Approximately 35 percent of beef, veal, pork, and lamb produced in the U.S. is processed. Of this, 75 percent is pork. Examples of processed meat products include sausages, cured whole muscle cuts, restructured, and breaded. Sausages are classified as follows: fresh, uncooked and smoked (kielbasa), cooked (braunschweiger, liverwurst), cooked and smoked (bologna, frankfurters), dry and/or semi-dry (pepperoni), fermented (summer sausage, salami), and loaves (pickle loaf, Vienna sausage loaf). Cured whole muscles include hams, corned beef brisket, bacon, pastrami, and pork shoulder. Restructured processed meats include boneless hams and smoked/sliced beef. Restructured products are similar to sausage but are formed to look and taste like whole muscle products. Fish sticks and chicken patties are examples of breaded processed meats.

Meat By-products

"We use all parts of the pig except the squeal and the curl in its tail." You may have heard this expression. The by-product industry is an integral part of meat animal processing, both historically and today.

Meat by-products (offal) are classified as either edible or non-edible. Edible by-products include liver, heart, tongue, brain, sweetbread, tripe, oxtail, chitterlings, mountain oysters, and lard.

Inedible by-products include a myriad of examples and uses. Table 6.1 details these inedible by-products.

Summary

Our meat supply chiefly comes from cattle, swine, sheep, chickens, turkeys, fish, and shellfish. The meat is processed first into primal cuts, consisting of the chuck, rib, loin, and round region along with whole carcasses and fillets. Subprimal (retail) cuts are usually smaller in portion than primal cuts and are therefore more numerous. Processed meat products are attractive to today'sconsumer due to their ease of preparation, controlled portions, shelf life, and low waste.

Figure 6.1 - Beef

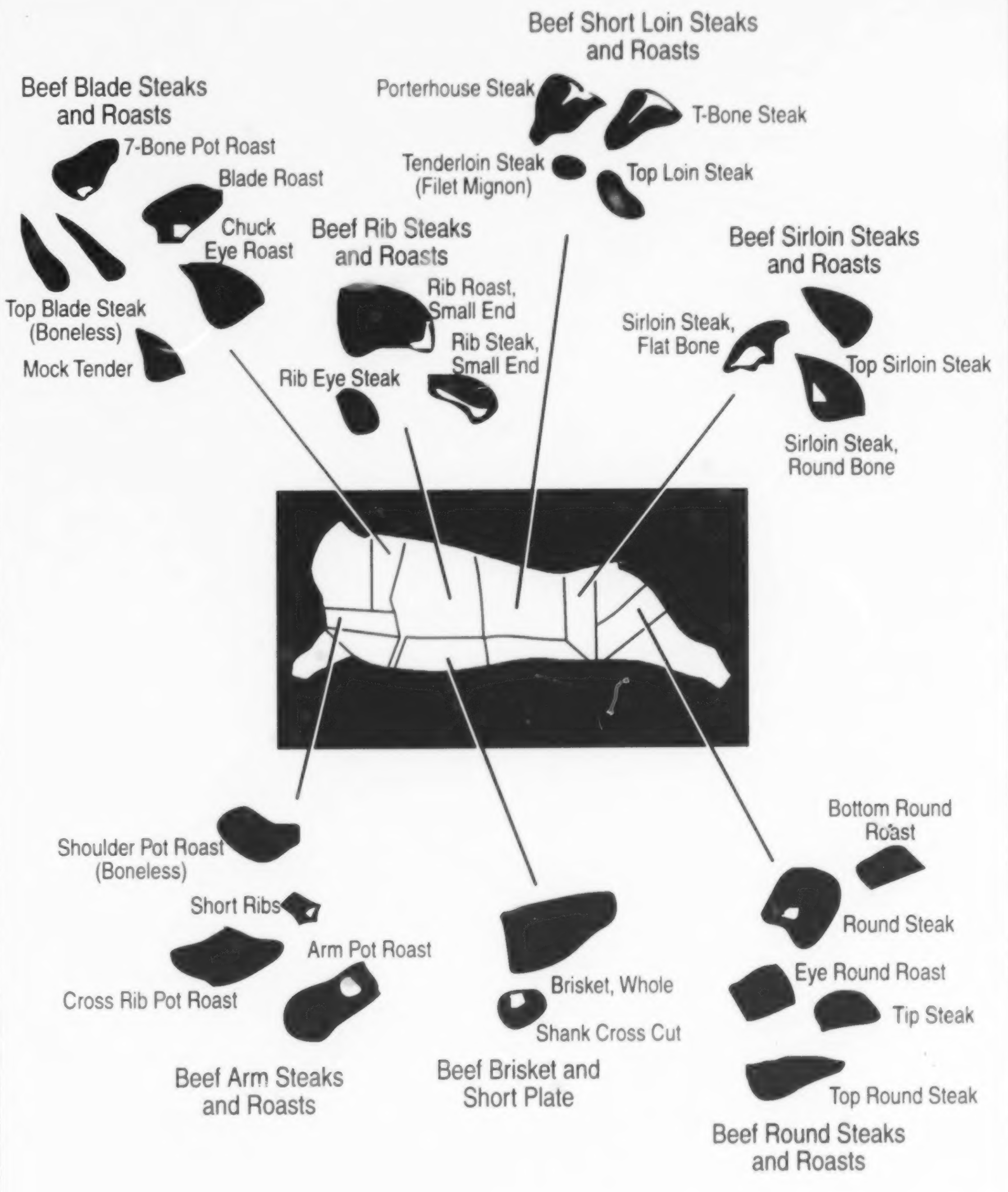
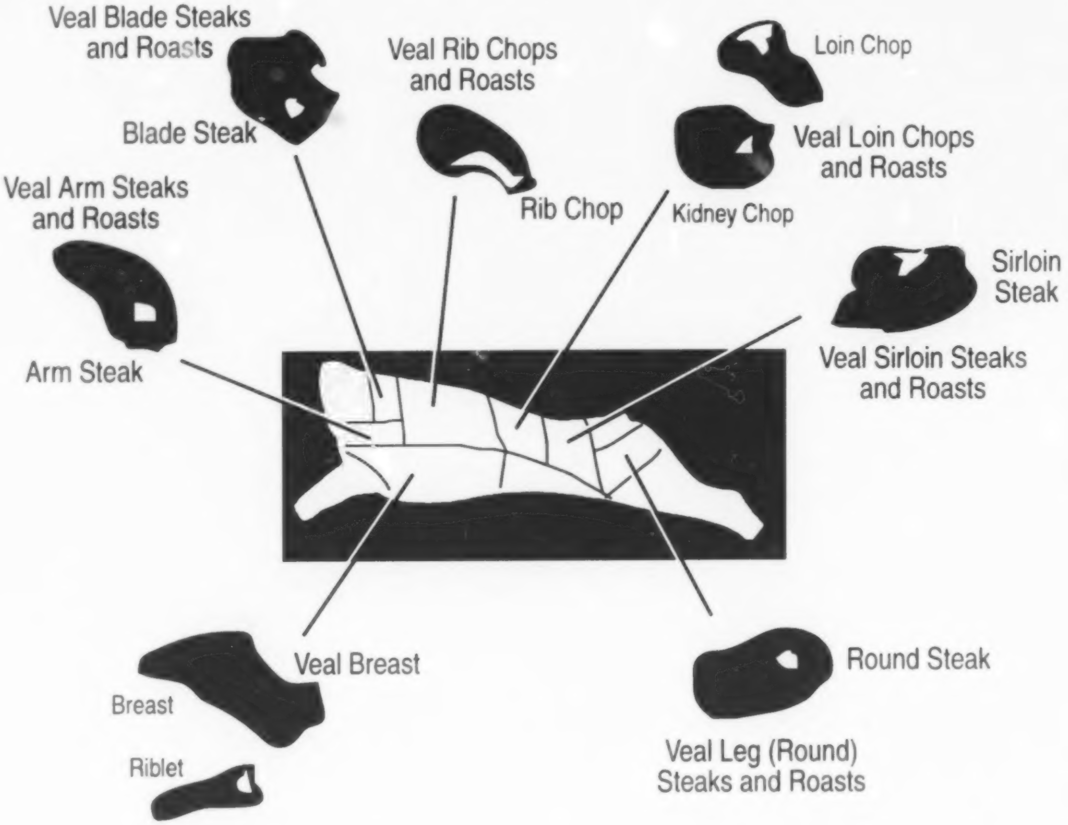


Figure 6.2 - Veal


Veal Blade Steaks and Roasts
Blade Steak
Veal Rib Chops and Roasts
Rib Chop
Loin Chop
Veal Loin Chops and Roasts
Kidney Chop
Veal Arm Steaks and Roasts
Arm Steak
Sirloin Steak
Veal Sirloin Steaks and Roasts
Veal Breast
Breast
Riblet
Round Steak
Veal Leg (Round) Steaks and Roasts

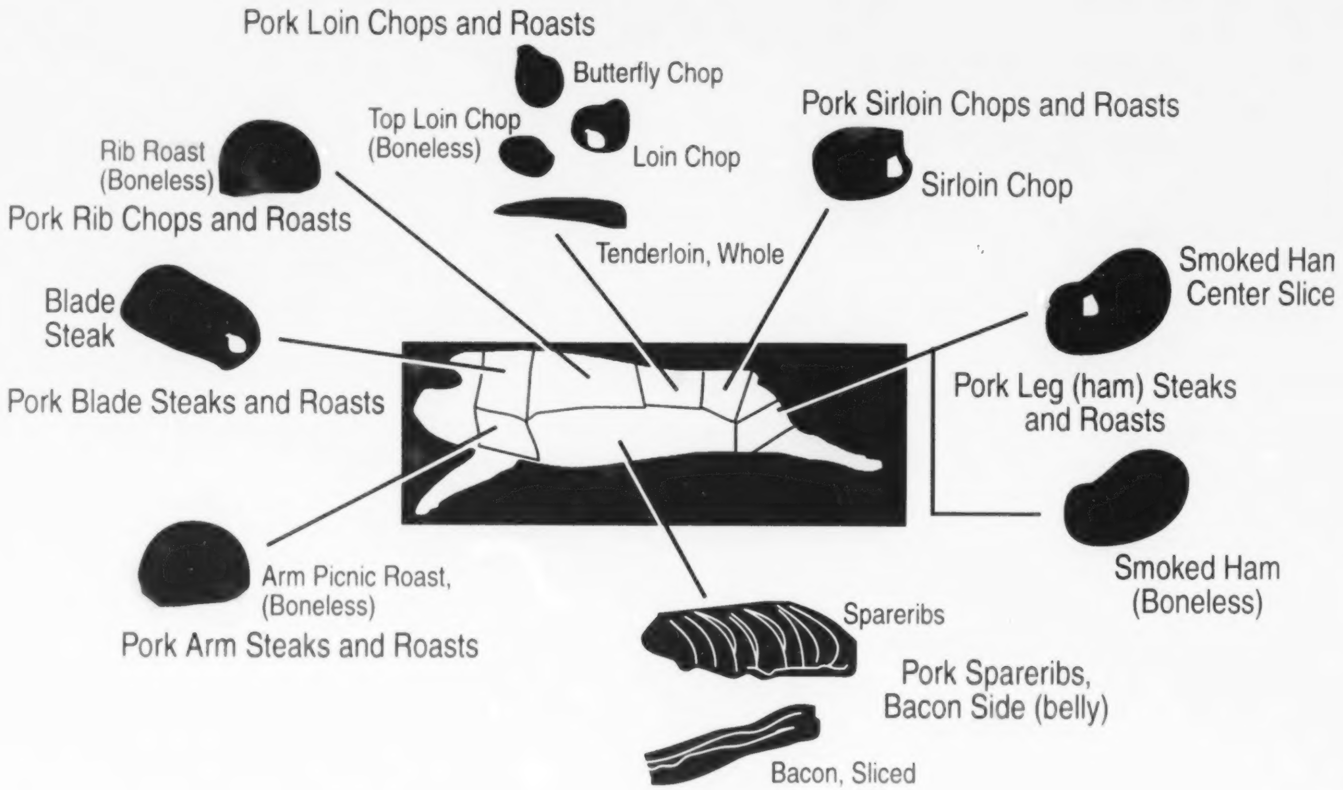
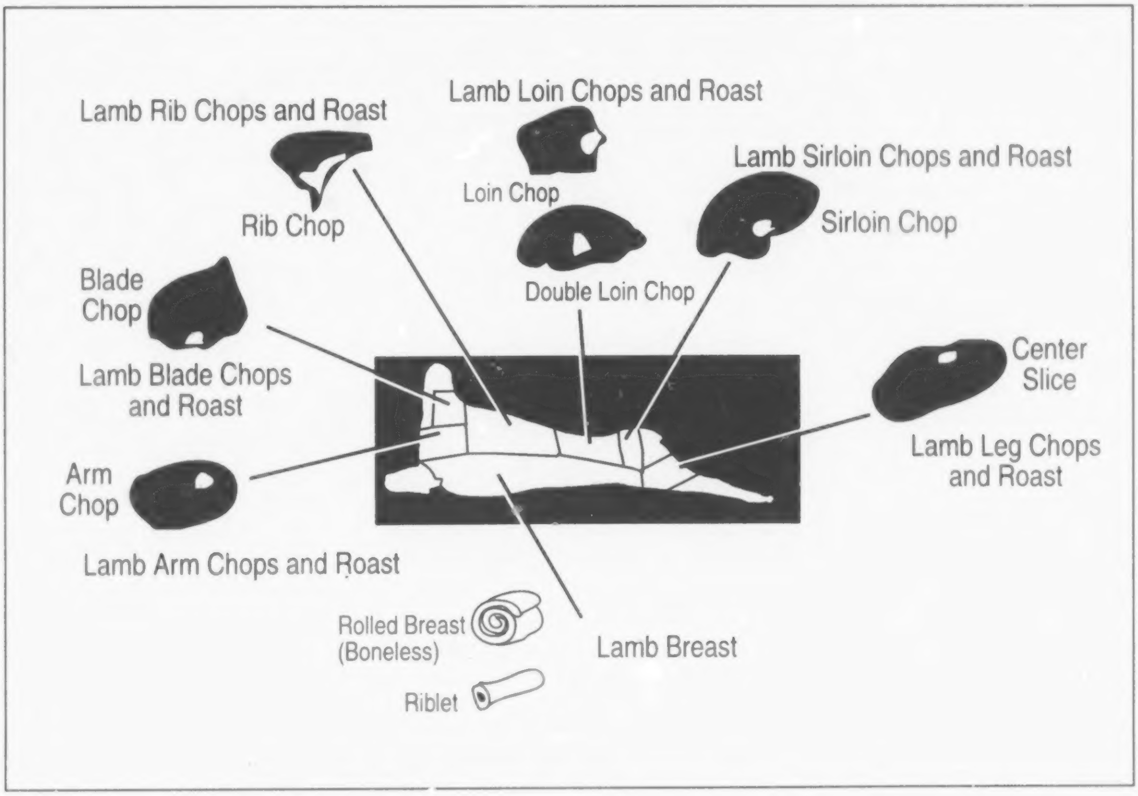


Figure 6.3 - Pork

Figure 6.4 - Lamb



About 35 percent of our meat supply is marketed as processed meat. Processed meats range from whole muscle cuts to restructured, breaded and sausage types. Most processed meat is in the form of sausage. Meat by-products (offal) are an integral part of the processing industry. Edible and non-edible by-products are useful as food, feed, pharmaceuticals, clothing, and household supplies.

Credits

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Table 6.1 - Animal By-Products

By-product	Used for
fats	soap, animal feeds, oils, fatty acids
tankage	soft tissue processed in a wet-rendering system used for protein, Ca, P source in feed
bone meal	used for protein, Ca, P source in feed
feather meal	used for protein, Ca, P source in feed
blood meal	used for protein, Ca, P source in feed
fish meal	protein source
hides and pelts	clothing, leather
adrenals	epinephrine*, corticosteroids*
blood	plasmin*, thrombin*, fertilizer, hair conditioner
brain	vitamin D_3*, thromboplastin*
gall bladder	cortisone*, chenodeoxycholic acid*
intestines	heparin* and casings
pancreas	insulin*
ovaries	estrogen*, progesterone*
parathyroid	hormones*, proteases*
pineal gland	melatonin*
pituitary gland	prolactin*, adrenocorticotropic hormone*, growth hormones*
skin	gelatin, glue
spleen	splenin fluid* (affects capillary permeability)
stomach	antacids
thyroid	thyroxin*
feathers	pillows
hair	brushes, upholstering
bones	dice, crochet needles, buttons

*pharmaceuticals

Lesson 7: Processing Meat Animals

By the beginning of the 20th century, meat packing was the nation's largest industry. Its one billion dollar annual sales exceeded the total yearly budget of the U.S. government! The refrigerated railroad car had quickly changed the focus of livestock producers from producing animals excelling in stamina to animals bred for carcass quality. By 1880, the U.S. was exporting beef to England, which had long claimed to have the world's best beef. Gustavus Swift, a meat packer from Chicago, established the first refrigerated railroad car service. Soon to follow was Philip Armour, another Chicago meat packer. These men helped convert meat processing into a mechanized industry. Chicago had the reputation as the hog butchering capital of the world.

Steps in Processing Meat Animals

Modern processing techniques are quite different than those used in the early 1900s, yet the multi-step agenda remains. Depending on the meat species being processed, the steps may vary.

Immobilization is the first step in processing a meat animal. Usually the animal is stunned with either a rod (mechanical), CO_2 (chemical), or an electrode (electrical). Once the animal is stunned, it is stuck with a sharp knife, severing its carotid arteries and jugular vein. A good stick can remove up to 50 percent of the animal's total blood. The process is called exsanguination. It is important to bleed all meat animals thoroughly and quickly. Immediately following death, the heart continues to pump and will do a thorough job of removing the blood.

The Kosher method of exsanguination is performed by a rabbi or shohet. The animal is restrained without stunning it and cut across the throat in a single stroke. This process requires much skill. It is considered by some religious groups to be more humane than the more commonly used stunning procedures.

Rigor mortis (stiff death in Latin) is an essential process in the conversion of live muscle to meat. After death, the biochemistry of muscle tissue changes. The muscle will use up energy (from glycogen - a complex carbohydrate found in animal tissue). However, since the blood is no longer flowing to remove the by-products of metabolism, lactic acid builds up in the muscle. This reduces the pH, causing a complex series of reactions that results in the contraction of the muscle fibers. This contraction makes the muscle feel hard or stiff, thus the name rigor mortis.

After more time, the muscle fibers will begin to relax. The relaxation of muscle post-rigor is sometimes called the resolution of rigor. This process is greatly influenced by temperature, being faster at higher temperatures. If you read murder mysteries, you may have noticed the coroner using body temperature and the state of rigor to help fix the victim's time of death. In processing meats, the time and temperature during rigor are carefully controlled to maximize tenderness. This part of the process is sometimes called aging. In France, the aging process is manipulated to achieve maximum tenderness. The meat becomes almost spoiled by U.S. standards. This process is known as mortification and produces highly prized (and very expensive) meat products.

Beef cattle are immobilized. Immobilization may be by an electrical jolt, which speeds the rigor mortis process and tenderizes the meat. Rodding the weasand is the next step. This procedure separates the esophagus from the trachea and allows the abdominal cavity organs to be pulled out separately from the thoracic cavity organs. Removing the head and neck hide, or heading, is the next step. This precedes shanking, or removal of the foreshanks and rear shanks. Siding, or skinning, follows shanking. Finally, evisceration, or removal of the abdominal and thoracic viscera, precedes splitting the carcass into halves. The carcass is now ready for refrigeration, inspection, and grading.

Hogs are immobilized, stunned and stuck, and then scaled or skinned. Scalding in 141°F-145°F water permits removal of the hair. Heating at this temperature causes the protein in the hair follicles to denature, thus loosening the hair. Removal of hair and scurf (the pigmented epidermal layer) follows. "Polishers" are mechanical devices used to remove the hair in a are mechanical devices used to remove the hair in a scraping fashion. The toenails are removed along with the skin and hair on all four feet. If the hog's head is to be used for human consumption, its inner ears must be removed. This eliminates dirt and wax. The head is removed, followed by evisceration, splitting, inspection, refrigeration, and grading.

Following immobilization, stunning, and exsanguination, lambs are pelted (skinned). It is during pelting that lamb carcasses are differentiated from mutton. The front foot is removed at the "break joint", or at the swelling at the lower part of the lamb's cannon bone. In sheep older than about 15 months, this joint is ossified, and the foot is removed at a slightly lower point called the spool joint. After pelting, the head is removed. The esophagus and trachea are separated just before evisceration. The carcass is then ready for refrigeration, inspection, and grading.

Chickens and turkeys are immobilized and stuck to remove the blood. Following bleeding, birds are defeathered. If they are scalded, the carcass is dipped into 150°F-160°F water for only a short period to avoid cooking the skin. The hot water denatures proteins of the feather follicles; this loosens the feathers. If the bird is to be dry-picked, a knife blade must be inserted into the cleft in the roof of the mouth and forced through to the rear lobe of the brain. This process relaxes the feather muscles. This relaxed condition only lasts for 2-3 minutes before rigor mortis begins so feathers must be removed quickly in this process. Following defeathering, the carcass is chilled to 32°F-36°F. The final steps are evisceration and grading.

Most fresh water fish have their heads removed behind their gills. Then, the scales and the tail fin are removed. The entrails are removed by cutting from the anus to the headless area. The body cavity should be thoroughly rinsed and the product chilled.

Processing Fresh Meat Products

Following the slaughtering process, most carcasses undergo further processing before they reach the consumer. The first technique used is carcass size reduction. Beef carcasses are split in half then quartered between the 12th and 13th ribs. Approximately 52 percent of a beef carcass, by weight, is in the forequarters with the balance in the rear quarters. Veal is processed into fore and rear saddles or halves. Almost all of today's beef is sold as boxed. Pork carcasses generally undergo processing to subprimal cuts prior to leaving the slaughtering facility. Lambs, in contrast, are usually shipped whole. Poultry carcasses are shipped either whole or pre-cut. Shellfish are usually shipped whole while fish may be shipped whole or portioned (fillets).

Following carcass size reduction, fabrication of the primal cuts takes place. Examples would be the removal of the relatively low value vertebrae from the whole rib or possibly deboning the entire rib primal cut. Subprimal fabrication is the third step. Here primal cuts are transformed into roasts, steaks/chops, and ground meat. Steaks are generally portions of muscle cut 3/4"-1" thick. Roasts are cut with a thickness of at least 2". Ground meat is free of bones, cartilage, and other heavy connective tissue. Ground meat must be 70 percent lean. Some primal and subprimal cuts undergo deboning, for example, a boneless chuck roast or a fish fillet. Patty production is conversion of boneless meat into uniform, ready to cook patties. Another processing technique involves shelf-life extension. Methods include freezing, heat pasteurization, heat sterilization, curing and smoking, dehydration, irradiation, and, the most popular method, refrigeration.

Tenderization, or improving the meat's tenderness, can be accomplished with either mechanical or enzymatic methods. Mechanical tenderizers pass a bank of needles through the muscle to sever connective tissue and muscle fibers. Enzymatic tenderization uses tropical plant (e.g., papaya, pineapple, fig) enzymes to degrade connective tissue.

Control of composition by restructuring is another processing technique used in the food industry. Restructured meats are those that have been ground, flaked, or chopped and formed into steak/chop or roast-like products. Through restructuring, the percent lean, water content, etc., can be carefully controlled.

Finally, portion control or product sizing is a processing technique used for fresh meat products.

Meat Quality Factors

Various factors affect meat quality. Factors can be production-related, be inherited, or occur during processing.

Production-related factors include: age of animal, health and nutrition of the live animal, and how it is sorted and hauled. As animals get older, their muscles have walked many miles and carried heavy loads, thus reducing their tenderness when consumed. Young animals are, therefore, more desirable in terms of meat tenderness.

Obviously, it takes a healthy animal to produce a healthy carcass. When animals are sick, their bodies draw energy, chiefly fat, from their muscles. The influence of diet on the physical properties of muscle is of minor importance, so long as there are no serious nutritional deficiencies.

Sorting and hauling can have substantial effects on a meat animal. If improperly done, bruising and/or stress may result. Stress on an animal just prior to slaughter can have a dramatic effect on carcass quality. Stressed animals have higher temperatures, lower muscle pH levels due to lactic acid build-up, and early onset of rigor mortis. This can cause muscle tissue to be pale in color, soft in texture, and excessively wet. This condition is called pale, soft, and exudative (PSE). Animals that have survived a stressful period but have not had sufficient time to recover may have dark meat. This is because of a glycogen deficiency in the muscle tissue. As stress increases, lactic acid increases and pH values decrease.

Research indicates that the physical properties of muscle are at least moderately heritable. In beef cattle, heredity is likely to influence tenderness by 60 percent color and firmness by only 30 percent. Heredity influences tenderness by 30 percent, marbling by 25 percent and color and firmness by 30 percent in swine.

Processing-related factors include: sanitation of the processing plant, efficient immobilization and exsanguination, postmortem temperature, postmortem handling, processing sanitation, water holding capacity, and color control.

Certainly, to avoid contamination, consumers expect processing plants to have sufficient sanitation practices. These include proper cleaning/disinfecting of equipment or personnel, absence of cross contamination between offal and carcass, absence of rodents, etc.

Efficient immobilization and exsanguination are important to avoid unnecessary stress. Immobilization should be followed immediately by rapid bleeding to prevent the animal from regaining consciousness and to allow the heart to aid in the bleeding process.

Low postmortem temperatures inhibit microbial growth. Postmortem handling, specifically carcass suspension and prerigor processing, can affect carcass quality. If a carcass is suspended by the achilles tendon, the psoas (tenderloin muscle) is placed under a maximum amount of tension. Consequently, it is extremely tender when compared to muscles allowed to shorten freely during rigor mortis. When a carcass is suspended from the pelvis, the tension is increased in round and loin muscles making them more tender.

The interval of time between slaughter and meat grinding can affect physical properties of the finished product. To maximize the juiciness and water binding properties of sausage, the meat should be ground before onset of rigor mortis. To ensure a moist cut of meat and a higher water holding capacity, surface area must be properly covered and/or packaged. Processors desire to retain the brightest meat color to meet consumer expectations. Whenever meat tissue lacks oxygen contact, like the portion permitted to remain in contact with the surface of a pan, it discolors to a dark red. Meat cutters must ensure proper oxygen contact with meat. They must also be careful to ensure that improper lighting or over-exposure to oxygen does not occur because these, too, can discolor the meat.

Meat Industry

The meat industry represents producers, packers, processors, retailers, and food service operators. In a vertically integrated industry, the packers not only process the meat animals but they also raise the animals and often mill the feed they eat. Whereas with an independent structure, the packer purchases the meat animals from the producer.

The poultry industry in the United States is almost totally vertically integrated. The company that owns the processing plant owns the birds and may also own the feed company. Producers contract with large companies to produce the chickens, while the companies supply the chicks and feed. The producer usually provides the housing, utilities, and the labor. Often the contract producer receives a graduated fee plus a bonus that reflects bird performance and management skills.

Only about five percent of the pork industry is vertically integrated. Usually, lamb and beef processors are independent from producers.

The National Live Stock and Meat Board represents beef, pork, and lamb producers, packers, processors, and retailers. The National Broiler Council and the National Turkey Federation represent the poultry industry in terms of research, education, and promotion.

Summary

The United States has a rich history in meat packing, dating back to the late 19th century. Meat processing, then and now, is a multi-step process beginning with immobilization and exsanguination. Skinning, evisceration, and cutting are processing techniques used on meat animals. Most of today's beef and pork are processed into primal cuts and placed in a box for transport. Further carcass processing/fabrication is done to prepare the meat for the consumer. Meat may be tenderized or restructured to improve its retail quality. The quality of meat depends on several production-related factors as well as heritability and processing factors. Today's meat industry is very diverse ranging from complete integration to independent producers and processors.

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Exploring Meat and Health. Chicago: National Live Stock and Meat Board, 1991.

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Lesson 8: Quality Grades, Inspections, and Brand Names in the Meat Industry

What do the words prime, choice, and select, mean to you? How are carcasses graded and what do their grades mean? The answers to these questions and others are found in the following lesson.

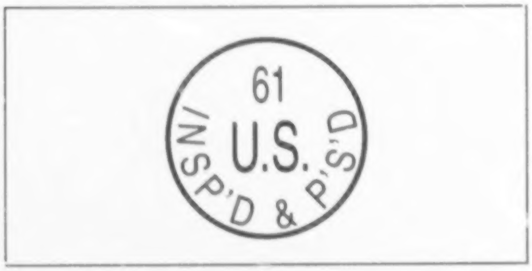
Inspection and Grading

The Federal Meat Inspection Act of 1906 made inspection mandatory for all meat that crossed state lines. The Wholesome Meat Act of 1967 required that meat sold within a state must meet inspection requirements at least as stringent as the federal system. Federal meat inspection is the responsibility of a division of the United States Department of Agriculture (USDA) called the Food Safety and Inspection Service (FSIS). State meat inspection is the responsibility of each state government. The federal government subsidizes each state's inspection efforts.

These inspection programs assure that only healthy animals are used for meat and that the processing facilities and equipment meet certain standards. The FSIS monitors the temperature of meat being processed, examines the labels and packaging, controls the use of additives, and controls imported meat.

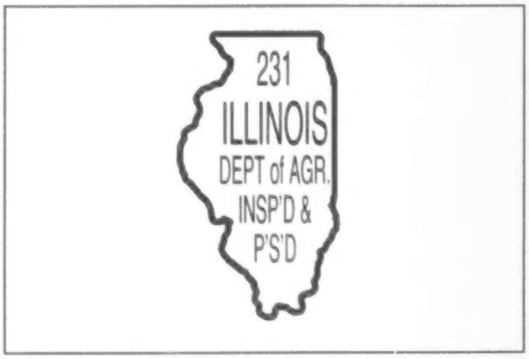
A round stamp of approval is placed on each primal cut when it passes inspection. This purple ink stamp contains the abbreviation for "United States Inspected and Passed" and the official establishment number assigned to that packing/processing plant. See Figure 8.1.

Figure 8.1 - Federal Meat Stamp



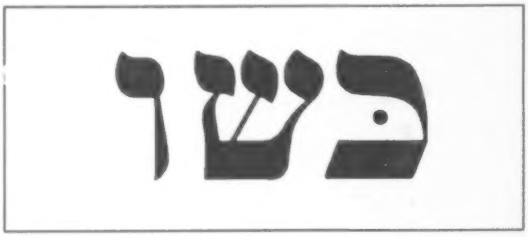
Some states have state inspection stamps, which also use purple ink and are usually the shape of the state itself. See Figure 8.2 for example. Missouri does not have a state inspection stamp.

Figure 8.2 - State Meat Stamp



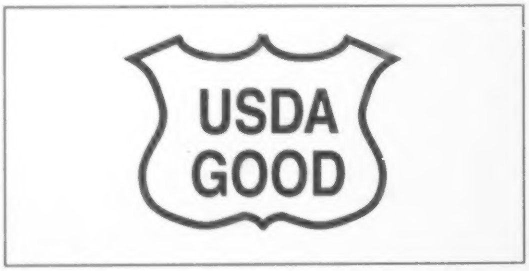
Qualified USDA inspectors do the inspecting. In the case of a Kosher plant, Kosher inspectors who meet USDA standards do the work. See Figure 8.3 for Kosher stamp.

Figure 8.3 - Kosher Stamp



Meat grading was established in 1927 when the USDA set standards for quality and cutability. Participation is voluntary on a fee-for-service basis, and is administered by the USDA. The USDA quality grade is indicated by a shield-shaped stamp which also uses purple ink. See Figure 8.4.

Figure 8.4 - Quality Grade Stamp



Grading costs are paid for by the consumer with other processing costs.

Not All Inspected

Not all meat in the U.S. is inspected. Currently there is no law requiring fresh fish to be inspected. Meat that is processed "Not for Sale" is also exempt from inspection. Also, squabs (pigeon), gamebirds, rabbits, and most wild game are exempt.

Quality Grades

Carcasses are quality graded so that packers can sort carcasses and primal cuts into groups of similar grade, and retailers can buy the appropriate grades for their markets. Quality grading assures consumers that the product conforms to an established set of standards which predict palatability and/or cutability (amount of lean).

Beef quality grading is based on marbling and maturity. Marbling is intramuscular fat viewed in the ribeye muscle. Intramuscular fat contributes to meat juiciness, tenderness, and flavor. The higher the degree of marbling the higher the quality grade assigned. Younger cattle qualify for prime, choice, select, and standard. Older cattle qualify only for commercial, utility, cutter, or canner grades. The USDA inspector determines the animal's age based on skeletal characteristics, and the color and texture of the ribeye muscle. Younger animals have red-colored bones and bright red lean (muscling). Older cattle show white bones and dark red lean.

Veal carcasses are graded on color, shape, and the amount of feathering (i.e., fat intermingled with the rib lean). The quality grades are: prime, choice, good, standard, utility, and cull.

Pork carcasses are graded on their leanness and meat quality (color, texture, etc.). Pork quality grades are acceptable and utility.

Sheep are graded on their maturity, color, and fat streaking. Lamb, yearling mutton, and mutton are three maturity classes based on differences that occur in the development of the muscular and skeletal systems. Fat streaking in the flank area and flank firmness are evaluated when grading. Prime, choice, good, and utility are the quality grades in lamb. The quality grades of yearling mutton are prime, choice, good, and utility. Mutton quality grades are choice, good, utility, and cull.

Poultry grading is based on several factors: conformation, fleshing, fat covering, presence of pin feathers, and exposed flesh. Disjointing, broken bones, and missing parts are also considered during grading. Poultry are graded into Grade A, Grade B, and Grade C poultry.

Inspection Detail

Inspectors must consider a variety of factors before they pass or condemn a carcass or primal cut. They inspect for unwholesome or adulterated carcasses, a sanitary processing plant, honest labeling, correct temperatures, correct use of additives, and a lab analysis that meets their microorganism specifications.

Quality Grade Versus Brand Name

Quality grade is independent from the brand name used. Many companies may use specific brand names to designate different grades of meat. The terms "star," "gold," or "lean" can be found on particular quality packages. These terms are the company's label not a quality grade determined by the USDA grader. Remember that the quality grade will be stamped with purple ink. The brand name may vary from company to company and from one location to another.

Summary

The citizens of the United States enjoy a safe and abundant meat supply. The safety of the meat is the responsibility of the USDA Food Safety and Inspection Service. Inspection is performed by qualified inspectors. Fresh fish, "not for sale" meat, certain game birds, and rabbits are not inspected. Quality grading is based on carcass cutability, color, and marbling/feathering. Quality grades and brand names are independent of one another. Many processing companies market their meat products under a variety of brand names, some of which designate a particular grade.

Credits

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Lesson 9: Products from Grain Crops

Grains have been an important aspect of the human diet since recorded history. Grains provide the world with most of its food calories and about half of its protein. Grains may be consumed directly or fed to livestock, which converts the grain to meat, milk, and eggs.

Primary Food Grains

Cereal grains include: wheat, corn, oats, barley, rice, rye, grain sorghum, and buckwheat.

Oil-bearing grains include: soybeans, sunflower, peanut, cottonseed, and canola (rapeseed).

While not strictly grains, dry legumes such as dry peas, lentils, and various beans (navy, pinto, black, etc.) are often processed in similar ways.

Primary Food Products

The major use of cereal grains is milling them into flour. Flour is processed into bread, pasta, bakery products, and other flour-based foods. Cereal grains are also used as raw material for a variety of breakfast foods and for direct consumption in the case of rice and corn (corn meal, corn flakes).

Wheat varieties are grouped into two major categories: hard wheat and soft wheat. Hard wheat is higher in protein, and yields a stronger, more elastic dough which is better for breadmaking. Duram wheat, a hard wheat, is the primary flour source for pasta products. Soft wheat is primarily used in cake and cookie making. Wheat is milled to separate the hull, germ, and endosperm. See Figure 9.1.

Corn is consumed in a variety of ways. Popcorn, for example, is a special variety that puffs or explodes when sufficient heat is applied causing the internal moisture to convert to steam. Corn is also milled to separate the hull, germ, and endosperm. See Figure 9.2. The majority of food corn undergoes milling. The endosperm or starchy component, is the most useful food component. Corn may be milled to produce corn meal, corn flour, corn starch, corn oil, and corn syrups (a variety of sweeteners).

Oats are processed into flour or rolled into the familiar rolled oats breakfast cereals. Oatbran is a good fiber source.

Barley is milled primarily to produce malt. Malt is produced after the barley germ has sprouted. Sprouted barley is high in enzymatic activity, especially a starch digesting enzyme called amylase. It is an essential element in the production of beer and many liquors. Dried, sprouted barley (malt) is used as a flavor agent in some breakfast cereals and malted-milk concentrates. Barley may also be milled into flour or eaten whole.

Figure 9.1 - Components of Wheat Grain

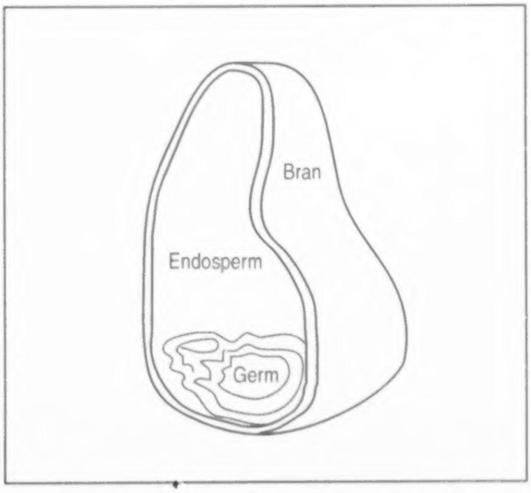
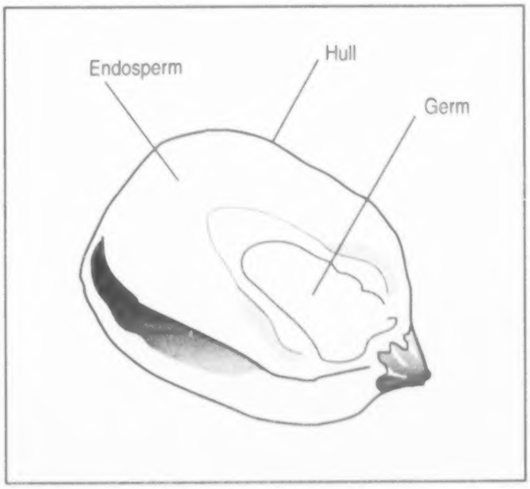


Figure 9.2 - Components of Corn Grain



Rice is the most important human food crop because of the billions of people who rely on rice as their staple food. Rice is primarily consumed as the intact grain, minus the hull, bran, and germ. Rice is ground into flour and can also be consumed as whole grain rice, which maintains a higher vitamin and mineral content than milled and polished rice.

Rye flour is mixed with wheat flour in the production of rye bread.

Oil-bearing grains are a source of edible oil as well as a substantial protein source. Soybeans are the most important oil seed. Soybeans are 20 percent oil. Soybean oil meal is 44-48 percent protein that contains amino acids necessary for a human diet. Soybean protein is often used to fortify other foods. Soybeans may also be roasted, converted to soy milk, soy flour, tofu or soy cheese, lecithin, and soy sauce.

Sunflowers are consumed whole or converted to oil. A sunflower is 50 percent oil.

Peanuts may be roasted and salted, or they may be processed into peanut butter or peanut oil.

Canola is an important oil seed in countries with cool climates. Canada produces many times more canola (rapeseed) than soybeans. Canola is processed into cooking oil.

Lastly, dry legumes are an important part of the human diet. Beans and dried peas are high in protein and low in oil content. Legumes are converted to flour and used in baking in many parts of the world.

By-Products

By-products, or non-principal use products, from food grain processing are important ingredients in livestock feeds and pet food. Wheat bran, corn gluten, rice hulls, germ, distiller's grain (wet remains of grain following malting), peanut hulls, and midlings (the oily germ) are some examples.

Non-Food Products

Food/feed grains are the subject of research to determine new uses. There are hundreds of uses for grains. Corn starch can be used to make a biodegradable substitute for plastic. It is used in diapers, packing nuts, ethanol, paper production, encapsulated herbicides, etc. Corn is also used in the production of ethanol, lecithins, paints, antibiotics, dyes, paper, linoleum, etc. Soybeans can be converted to soy diesel, soy ink, soaps, pesticides, cosmetics, animal feeds, paints, etc. Peanut hulls are used as "cinders" on slick roads.

Summary

Grains have always played a major role in the human diet. Cereal grains include wheat, corn, oats, barley, rice, rye, grain sorghum, and buckwheat. Cereal grains are normally ground into flour before further processing. Oil-bearing grains include soybeans, sunflowers, peanuts, cotton-seed, and canola. Oil-bearing crops produce an edible, high protein oil when cooked. Dry legumes are represented by dry peas, lentils, and various beans. Dry beans are an important low oil, high protein food.

Food grains produce several by-products when they are processed. Animal feeds are the primary beneficiary. Non-food products derived from food grains are a rapidly expanding field. Corn and soybeans are the two major grains used for numerous industrial products.

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Lesson 10: Processing of Grain Crops

Since the beginning of time, people have enjoyed eating grain crops. Crops like corn, rice, wheat, oats, and barley have been a steady supplier of complex carbohydrates. Leguminous crops supply protein to the diet. This lesson will focus on the processing of these grain crops.

Steps in Processing Grain

Before becoming human food, most grains are processed. They are processed to improve their digestibility, flavor, texture, and storage qualities.

Grain must be harvested and transported to the appropriate processing plants. Transporting grain is accomplished by rail, barge, or truck. Once at the processing plant, the procedures vary depending on the type of grain.

Cereal grains undergo milling. There are two types of milling: dry and wet. Dry milling includes the removal of any foreign seeds and soil; conditioning the grain to the proper moisture level (17% for wheat, 21% for corn); and loosening and separating the germ, bran (hull), and endosperm. The germ, bran, and endosperm are separated after they have been passed through a roller. The flakes of bran and the flattened, semi-plastic germ are separated from the small, brittle particles of endosperm by the sieves under the rollers. The pulverized endosperm is now in the form of grits or meal and may be further processed into flour.

Wet milling is a process used mostly by corn processors. It involves steeping the corn in large tanks of warm water that contain acid and sulfur dioxide (SO_2). The soft kernels are passed through a grinder to break up the kernels. The result is a paste that is pumped into water-filled settling troughs. The germ, which has the lowest density, can be skimmed off the top. It is then pressed for oil. The slurry passes through screens to separate the bran from the endosperm. High speed centrifuges separate the remaining starch and protein fragments found in the endosperm. The starch is dried to yield corn starch and corn sugars. The dried protein becomes corn gluten.

Malting is primarily a process used for barley. The barley seed is germinated to activate dormant enzymes. The swollen grain is gently kilned to dry the seed without destroying the enzymes. The dry malt is then storage-stable.

Oil seeds must be roasted to remove the oil. The seed is steamed and crushed to rupture the cellular structure and expose the free oil. The oil is extracted by high pressures, or dissolving the oil in solvents such as hexane or liquified carbon dioxide. The remaining meal or flakes are high in protein and may be further processed into flour.

Enrichment and fortification are used to improve the nutritional characteristics of some processed grains to meet U.S. nutrient standards. Wheat and rice often undergo processing procedures that unintentionally remove nutrients. These nutrients are often added back into the food product. These products are enriched. Some nutrients are added to products to help ensure good nutrition in an entire population. These products are fortified.

Extrusion is a process that combines several operations, including mixing, kneading, shearing, heating, cooling, shaping, and forming. Extrusion compresses the food into a semisolid mass and forces it through a restricted opening. The moisture in the food turns instantly to steam, causing the product to expand or puff. Many breakfast cereals and snack foods, macaroni, textured food products, and confections have been extruded.

Preserving Grain Products

Nature, in the form of sun rays, will dry grain to about 14 percent moisture. At this moisture level, spoilage is usually not a problem. Grain processors eliminate spoilage problems by drying meal, flour, pasta, and grain to below 14 percent moisture, (3-5 percent). Very few grain products contain an added preservative. Insects pose the greatest spoilage threat. Thus, packaging in insect-proof containers is vital. Insects along with molds and bacteria can be destroyed by irradiation treatments of flour, cornmeal, etc.

A second method to preserve grain products can be accomplished by regulating osmotic pressure.

Corn syrup contains sufficient nutrients to promote bacterial growth. Growth of microbes is prevented, however, because of the high osmotic pressure found in syrup due to its sugar concentration.

A third technique used to preserve grain in Europe and Russia is irradiation. High energy atomic particles are used to bombard the grain and destroy insects, molds, and bacteria. The irradiated grain must be protected from future contamination by proper packaging.

Grain Inspection

The quality of a food product can only be as good as the raw materials. The laws that govern grain inspection today were initiated by the Grain Standards Act of 1916. Grain is inspected to determine its quality, thus influencing its price.

Grading Grain

There are several factors to consider when grading grain. These include test weight, moisture, damaged or split grains, heat damaged grains, foreign material, and diseased or treated kernels. These variables carry the potential to alter a grain's food value. Variances in test weight can affect density, moisture levels affect storage life, damaged grain may hinder the germ-endosperm-hull ratio, and excess heat can reduce enzyme activity and protein content.

Some grains have different classes or subclasses. Each class is also graded. Corn is divided into three color classes: yellow, white, and mixed. Soybeans are also classified by color, however, in only two classes: yellow and mixed. Wheat is extensively classified into eight areas: hard red spring, hard red winter, soft red winter, Duram, hard white, soft white, unclassed wheat, and mixed wheat.

Corn and wheat are graded into U.S. Grade 1, U.S. Grade 2, U.S. Grade 3, U.S. Grade 4, U.S. Grade 5 and U.S. Sample grade. U.S. Grade 1 is the highest quality grade.

Oats and soybeans may be graded as: U.S. Grade 1, U.S. Grade 2, U.S. Grade 3, U.S. Grade 4 or U.S. sample grade. The higher the sample quality, the closer to U.S. Grade 1.

Barley and oats do not have any classes or subclasses.

How Grades of Grain are Used

Grading grain is essential for fair trade. It provides information in an understandable language for buyers and sellers. It facilitates selling/buying grain without personal inspection.

U.S. Grades 1 and 2 grain are primarily used for food production. U.S. Grades 3, 4, 5, and U.S. sample grade grains are normally processed or exported for animal feed. This is not to say, however, that it cannot be upgraded by mixing U.S. Grade 1 or 2 grain with it. If the grain contains too many cobs or cockleburs, these can be cleaned out and the grain upgraded. On the other hand, if a mold (aflatoxin) is present, no amount of mixing would be permissible.

Food Grain Industry

The food grain industry is diverse in size, ranging from small locally owned processors to multi-million dollar corporations. This industry also includes contract growers (raise specific varieties for contracted mill), independent growers, and corporate production sites. The Kansas City Board of Trade plays a significant role in the world's wheat trade while the Chicago Board of Trade deals with the buying and selling of many different grains.

Summary

Most grains are processed to improve their flavor, texture, storage quality, and digestibility. Following harvest, grains are transported to processing mills. Dry milling separates the bran, germ, and endosperm with a series of rollers and sieves. Wet milling is useful for corn processors. This involves swelling the grain with moisture, rolling it into a paste, and then separating the constituents by density. Malting, roasting, fortification and enrichment are other means used to process grain. Oil-seed grains must be roasted to remove and process the oil. Extrusion is a process that compresses a semi-solid mass and reforms it as it passes through a restricted opening.

Grain products rely on a low moisture content or a high sugar concentration to prohibit microbial invasion. Grain inspection and standards identify grain quality, and thereby, are essential for fair trade. Grades for corn and wheat are similar. Grades for oats and soybeans are very much alike. Test weight, moisture, damaged kernels, heat damage, foreign material, color, variety, and evidence of diseased or treated kernels all contribute to grain grades. The US grain industry is very diverse in structure and organization.

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Lesson 11:

Fruit, Vegetable, and Nut Products

Fruits, vegetables, and nuts are important sources of vitamins A and C. They also supply necessary minerals in the human diet. Nuts provide a protein source in snacks, cookies, and confectionery items.

Major Classes of Fruits, Vegetables, and Nuts

Fruits can be divided into six major classes. These categories include melons (cantaloupe, honeydew, watermelon), drupes or single pit fruits (apricots, cherries, peaches, plums), berries (grapes, blackberries, cranberries), pomes or multiple pit fruit (apples, pears), citrus (oranges, grapefruit), and tropical (bananas, dates, figs, pineapples, mango, papaya).

Vegetables are classified relative to the anatomical portion that is eaten. These include earth vegetables (potatoes, onions, sweet potatoes), herbage vegetables (cabbage, spinach, lettuce, celery, rhubarb), and fruit vegetables (peas, green beans, sweet corn, squash, tomato).

Nuts have two classifications: cultivated tree nuts (almonds, Brazil nuts, cashews, pecans, black walnuts), and wild nuts (apricot nuts, beechnuts, chestnuts, chinquapins, heartnuts, hickory nuts, pecans, and black walnuts). Certain nuts may be included in either classification depending on whether they have actually been cultivated or grown in the wild.

While peanuts are classified as legumes, they are processed very similarly to tree nuts.

Products

The products from fruits, vegetables, and nuts are numerous. Fresh fruits and vegetables are in the largest demand. Frozen fruits and vegetables (e.g., corn, lima beans, strawberries) are a product, along with canned fruits and vegetables. Juices obtained from tomatoes, prunes, oranges, apples, and grapes are an important part of the diet, while purees, like baby food and tomato sauce, are also useful products. Processed products like apple sauce and cranberry sauce are other products, as well as, jellies, jams, dried fruits, and vegetables. Nuts are processed into products which include nut meats, shell nuts, cracked nuts, and roasted nuts.

Quality Grade Factors

Fruits and vegetables are graded, based on their quality. The quality grade standards include maturity, instrumental evaluation (used to measure compression/texture and size), color, size, shape, firmness/texture, aroma, variety of fruit or vegetable, harvesting method, acid concentration, sugar to acid ratio, and evidence of any disease or physical damage. Canned fruits and vegetables are evaluated on their canned weight. Grades include U.S. Grade A or U.S. Fancy, U.S. Grade B or U.S. Choice, U.S. Grade C or U.S. Standard, and U.S. Grade D or U.S. Substandard.

By-Products

The processing of fruits, vegetables, and nuts produces a variety of by-products used for jelly-making, animal feed, and confections. These include rinds, peels and shells, pits, and non-juice solids.

Crop Characteristics

The variety of fruit, vegetable, or nut determines how it is processed. Processing plants are located in specific regions of the country to efficiently process specific varieties.

Characteristics that determine how a fruit, vegetable, or nut is to be used include: time of maturity and yield, response to weather, pest and disease resistance, shape, size, resistance to physical damage during harvesting and processing, storage stability, suitability to certain processing methods, color of flesh, firmness when cooked and when raw, amount of juice, acidity level, and solids content.

These characteristics are directly related to the molecular composition and, therefore, variety of fruit, vegetable, or nut. There are more than 1,000 cultivars of apples and 3,000 cultivars of pears, for example.

Summary

Fruits, vegetables, and nuts are important components in the human diet. Necessary vitamins and minerals are found in these food sources. Classification of fruits includes melons, drupes, berries, pomes, citrus, and tropical. Vegetables are classified as earth, herbage, or fruit. Cultivated tree nuts and wild nuts are the two types of nuts. Products are available in a variety of forms: fresh, frozen, juices, purees, canned, jellies/jams, dried, nut meats, in-shell nuts, cracked nuts, and roasted nuts. Quality grades are based on physical and chemical properties and determine how the fruit, vegetable, or nut will be processed. By-products result from the processing of fruits, vegetables, and nuts. The method of processing depends on the variety of the crop.

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Lesson 12:
Processing Fruits, Vegetables, and Nuts

Fruit, Vegetable, and Nut Processing

Fruits and Vegetables - Fruits and vegetables are high water content foods. This promotes bacterial, yeast, and mold growth. If fruits and vegetables become partially dehydrated or wilted because of bruising or rough handling, their economic value sharply decreases. Processors, therefore, must practice superb techniques in handling and transporting these commodities. Processing techniques must also minimize natural enzymatic deterioration.

Much of today's harvesting is accomplished by mechanical pickers or harvesters. Because fruits and vegetables are delicate items, harvesting is usually conducted before maturity is reached. Ripening chambers containing ethylene gas are an important part of the processing of certain fresh fruits and vegetables. Other controlled atmospheric conditions, like temperature, humidity, O_2 levels, and light, are used to regulate shelf-life. Potatoes need large amounts of O_2, 5-7 days post-harvest, to develop their hard skin. Then they can be successfully stored under normal conditions.

Processors realize the need for immediate cooling of freshly picked produce. This has led to the development of mobile processing units that super cool produce immediately after harvest. Jet streams wash the product and begin to remove internal heat, and super coolers remove the remaining heat.

Freezing and canning are frequently used in the processing industry. Many fruits and vegetables are pitted, stemmed, cut, or cored before being frozen to a temperature of 20°F or less. Some fruits and vegetables may also be blanched. Canning operations include: blanching, peeling and/or coring, can filling, removal of air, sealing, retorting, cooling, and labeling.

The peels of fruits and vegetables may be removed by rotating drums; quick exposure to steam to expand the skins, immediately followed by water jets to remove peel; exposure to hot lye, followed by washing; or exposure to a burning flame, as in the case of onions.

Blanching, or inactivation of enzymes, is a critical step in fruit and vegetable processing. Blanching is heating the produce to 200° F for 2-5 minutes to deactivate the enzymes. For example, blanching prevents orange juice concentrate from becoming bitter, lipid or fat oxidation in frozen peas, and browning in cut potatoes.

An alternative to blanching would be to use an additive such as sodium bisulfite to prevent peeled potatoes from enzymatic browning. Excessive browning when sun-drying apricots and peaches is prevented with sulfur dioxide (SO_2).

Nuts - Commercial nut producers harvest their trees with mechanical tree shakers. Nuts are hulled as soon as possible by mechanical nut hullers. Sorting machines separate nuts by size and/or color. Pecans are dried to a 4.5 percent moisture level to prevent molding, discoloration, and breakdown of their oil.

When processing for nut meats, pecans are re-moistened to around 8 percent to reduce breaking of the meats. Then they are shelled. The meats are then packaged.

Processing in-shell pecans involves bleaching by washing in wet sand to remove black streaks, polishing, and waxing.

Roasted nuts are heated at 300°F in vegetable oil. After cooling, an oil coating is applied along with salt. The nuts are cooled a second time and then receive a "shine" oil treatment which seals on the salt. Dry roasted nuts are heated without oil.

If a nut butter such as peanut butter is to be produced, the nuts would undergo shelling, roasting, removal of skins, grinding, salting, and sugaring (optional) before becoming butter. Then the butter is packaged.

Nutritional Quality

Generally, fresh fruits and vegetables are highest in nutritional value. Frozen fruits and vegetables would rank second in nutritional quality. Canning fruits and vegetables requires a long processing period causing the destruction of many of the water-soluble vitamins. Dried fruits contain only trace levels of vitamin C.

The composition of nuts is not generally affected by processing treatments.

Treatments and Packaging

Fresh fruits and fresh vegetables are regular items at the grocery store. Many of these items have been transported hundreds of miles. Without certain treatments and proper packaging, these commodities would only be available on a regional or seasonal basis.

Fruits and vegetables may be treated with: ethylene gas to promote maturation; sodium bisulfite or sulfur dioxide (SO_2) to retard browning; waxes to prevent dehydration in apples and nuts; irradiation to inhibit sprouting in potatoes; and cool temperatures to slow enzymatic reactions.

Modern packaging places nuts in opaque containers to avoid the red spectrum of light which can cause rancidity. Fruits and vegetables are packaged in plastic with ventilation holes. This allows for a normal respiration process without moisture build-up. Certain produce is treated to improve the color or shine of the skin to increase eye appeal.

Organization of Industry

The fruit, vegetable, and nut processing industry is very complex. Processing plants are scattered over the nation. A growing number of producers are contracted by processors to supply a known quality and quantity of products. Cooperatives play a major role in pooling, processing, and marketing member production. Very large parent companies play a major role in fruit, vegetable, and nut processing. They often supply the necessary financial support and the name recognition of national brands. This is an industry known for its use of immigrant and migrant labor, and its reliance on national organizations to promote its products.

Summary

Fruits and vegetables are delicate and highly perishable items; therefore, careful attention to handling and transporting is essential. Because of the high moisture levels in fruits and vegetables, microbial and enzymatic deterioration must be carefully controlled.

Shelf-life and appearance enhancement are promoted with a variety of agents. These include additives, controlled atmosphere, coatings, irradiation, and packaging.

Independent producers, cooperatives, contract producers, large processing companies, promotional organizations, and migrant labor all play a part in fruit, vegetable, and nut production.

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Lesson 1: Factors That Affect Food Safety and Quality

Food safety is closely related to food spoilage, but they are not always the same thing. Food becomes unsafe when pathogens, pesticides, toxins or other potentially harmful chemicals are present. Foods that appear safe may contain toxins (poisonous plants), while other foods may look and smell very bad - yet still be quite edible (Limburger cheese). Food quality is a combination of safety and aesthetic factors.

Food Spoilage

Feeding a growing population is a large task. The effort is compounded due to food spoilage. Even if an adequate food supply is produced, it must be stored and prevented from deteriorating. Several factors cause deterioration: microorganisms in the form of bacteria, yeasts, and molds; activities of natural food enzymes; insects, parasites, and rodents; temperature (both cold and hot); moisture or dryness; air; light; and time. In essence, food undergoes progressive deterioration beginning at harvest. It is critical to know how much time the deterioration process takes.

Contaminants Influence Food Safety and Quality

When microorganisms attack food, they cause many deteriorative effects. They can ferment sugars; hydrolyze starches and fats; digest proteins; and form acids, pigments and discoloration. These can lead to rancid flavors, putrid odors, gas and foam production, and poisonous toxin production.

Enzyme activity is necessary in living plants and animals; however, it continues after harvest or slaughter. Unless these enzymes are inactivated by heat, chemicals, or radiation, they continue to catalyze reactions. Some of these reactions are desirable, like continued ripening of a tomato. Unfortunately, ripening or tenderizing beyond a critical point becomes food deterioration. The weakened tissue is subject to microbial invasion and rotting, development of rancid flavors, or browning and other discoloration.

In addition, insects cause damage, which permits microbial invasion. Parasites, like worms in raw fish and the Trichina worm in uncooked pork, can infect the person who consumes them and cause nerve and muscle damage. (The Trichina worm is no longer a problem in the U.S. pork industry.) Parasites can also cause dysentery. Rodents not only consume large quantities of food, but their excrement and urine can harbor several diseases such as typhus fever, the plague, salmonellosis, and leptospirosis.

Natural dehydrating may cause skin breakage which allows bacterial invasion. Freezing causes cell swelling which causes the cell membrane to rupture.

The remaining factors, temperature, moisture, air, light, and time, can contribute to physical and chemical deterioration. These can also lead to microbial invasion.

Production Practices

If a food product is to be consumed safely, it must be safe when it arrives at the processing plant, at the grocery store, and at the place and time of consumption. Food producers are responsible for growing safe products. Many producers are following Quality Assurance programs to document their practices.

Producers of animals must follow withdrawal guidelines for antibiotics and vaccines, follow recommended injection site procedures so as not to damage muscle tissue; and must sort, load, and transport animals as gently as possible to avoid bruising (bruised tissue deteriorates more quickly). Plant food producers document proper use and timing of pesticides.

Grain grade standards regulate grain quality. Producers use honesty as their policy in grain sales. To place rodent damaged grain on the bottom or treated wheat on the sides of the truck to avoid the grain sampler is dishonest and may be unsafe.

Food Additives

Food additives are one very useful tool to maintain the safety and quality of food during processing, storage, and distribution. A food additive is any substance added intentionally or incidentally to food to improve its appearance, flavor, texture, nutritional value, or storage properties. The Food and Drug Administration (FDA) tests all potential additives over a two-year period on at least two different species of animals. The FDA has compiled a Generally Recognized As Safe (GRAS) list which can be added to or subtracted from as needed. Additives may not be used to deceive the customer or lower the nutritional quality of the food. They cannot be used to conceal spoilage, damage, or low quality. There are over 2,000 additives which perform a variety of functions. The Food Additives Amendment of 1958 provides legal standards for both intentional and incidental additives.

Antioxidants prevent the breakdown of vitamins and lipids in foods exposed to oxygen. Common antioxidants are butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), Vitamin E, ascorbic acid (Vitamin C), and lecithin.

Bleaching and maturing agents change the yellowish color of freshly milled flour to white. Hydrogen peroxide whitens milk for certain cheese manufacturing processes.

Buffers, acids, and alkalies modify the pH.

Flavoring agents include spices, herbs, plant extracts, and artificial flavors.

Food colors are used extensively. Extract of annatto, caramel, carotene, and saffron are used in carbonated beverages, candies, and gelatin. In 1976, FD & C Red No.2 and FD & C Red No.4 were banned. Reliance on natural reds from grapes, beets, and cranberries has subsequently increased.

Nitrates and nitrites contribute to the flavor and pink color in cured pork. They also are antimicrobial agents.

Non-nutritive and special dietary sweeteners are used in low-calorie soft drinks, in dietetic foods, and by diabetics.

Nutrient supplements such as Vitamin D in milk, iodine in salt, and iron in cereal products are useful supplements to diets that may otherwise be deficient in those nutrients.

Preservatives extend shelf life and prevent deterioration. Common preservatives include sodium nitrite in processed meats, sodium benzoate in soft drinks, sodium and calcium propionates in breads and cakes, sorbic acid in cheese, and chlorine as a germicidal wash on fruits and vegetables. Sulfur dioxide is used to control browning of fruits and ethylene oxide is used to fumigate spices.

Sequestrants chelate or sequester trace metals and prevent them from causing oxidation or off-coloring. Citric acid and ethylenediamine tetra acetic acid (EDTA) are examples.

Stabilizers prevent food products from changing chemically. They are also called thickeners. Pectin, casein, gelatin, carrageenan, and gum arabic are common stabilizers use to thicken gravies, pie fillings, chocolate milk drinks, jellies, puddings, and salad dressings.

Surface active ingredients include emulsifiers to stabilize oil-in-water, water-in-oil, gas-in-liquid and gas-in-solid mixtures. Lecithin, monoclycerides and diclycerides are commonly used.

Miscellaneous additives include yeast in breads, calcium chloride used to firm fruits and vegetables, anticaking agents in salt, and gibberellic acid to stimulate growth in barley for malting.

Monitoring Food Safety

The USDA's Food Safety and Inspection Service is responsible for inspecting and checking the quality of food products as they enter and leave processing plants. The FDA must approve processing plants and processing procedures. These include the use of additives. Food products must be correctly labelled to show their ingredients and nutritional information.

The state, county, or local health departments have jurisdiction over food establishments and regularly inspect them for cleanliness and approved practices.

All meat must pass state or federal inspection for wholesomeness to guarantee the consumer that meat being purchased is from healthy animals, which were slaughtered and processed under sanitary conditions.

Federal inspection of meats and poultry is supervised by the USDA. Meat that passes federal inspection is stamped with a round, purple mark. State-inspected meat will have a different shaped inspection mark depending on the state. The inspection mark is placed only once on the wholesale cut, so it will not appear on every cut that is purchased.

Risk Assessment

Life is a risk. Eating is a risk. There is some level of risk associated with everything we do. You personally must assess the risk of whatever activity you wish to do, and then make a decision on whether to do the activity. Food safety is very important and is also a very popular topic. If you want to survive, you must eat. You must be rational in assessing the risk versus the cost.

Undesirable residues in the food supply is an area of popular concern. Residues may be heavy metals, pesticides, aflotoxins, hormones, etc. The food supply is randomly sampled and tested to meet safety standards. Today's testing equipment can measure in parts per trillion and beyond. In 1958, when the Delaney Clause was adopted, measurement was done in parts per million. What was once considered safe, may very well be removed from the market today. The Delaney Clause prohibited known carcinogens from being added to the food supply.

Consumers assess risk in a variety of ways. First, they use rational thinking and common sense. They consume food that has not expired; looks, smells, and tastes wholesome; is produced, processed, and retailed by reputable businesses; and meets U.S. safety standards. However, consumers are not always rational when assessing risk. Sometimes fear of a product may be more important than any assurances of safety the processor can provide. On the other hand, some people choose to ignore the risk because of the pleasure associated with the product (Consider cigarettes and raw oysters). Consumers are the final 'line of defense' in keeping foods safe for consumption. Some consumers have allowed the media to be very influential in their decision making.

Summary

Food spoilage may be caused by a wide variety of factors including microorganisms, natural enzymes, insects, parasites, rodents, temperature, air, moisture, light and time. In reality, progressive deterioration in food occurs. The critical question is how slow or fast is the process. Microbial contamination causes sugar fermentation, hydrolyzation of fats and starches, and many other negative effects. Enzymatic activity is a natural metabolic process and can be a positive or negative agent in food preservation. Insects cause spoilage which permits microbial invasion. Several other factors can influence food spoilage. One of them includes production practices used.

Our food safety is monitored by the USDA, the FDA, and health departments. Food additives are substances added intentionally or incidentally to foods to improve appearance, flavor, texture, nutritional value, or storage properties. All consumers must assess the risk associated with eating food and rely on common sense to determine their decisions.

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Lesson 2:
Problems with Food Deterioration

Food is subject to physical, chemical, and biological deterioration. The most obvious to the human eye, physical deterioration, will be discussed first.

Physical Changes from Food Deterioration

When food is exposed to excessive amounts of heat, cold, or circulating air, it may become dehydrated. Cracked skin found on fruits that have been frozen and thawed is another type of physical change. A broken or separated emulsion (example, salad dressing) in liquid foods that have been frozen and allowed to thaw is a third type of physical change. A fourth is texture degradation. This can be found in fluid milk that has been frozen, which causes curdles to develop.

Lumping, caking, or crystallization may result from an excess of moisture. Surface pitting on fruit is the result of storage temperatures that were too cold.

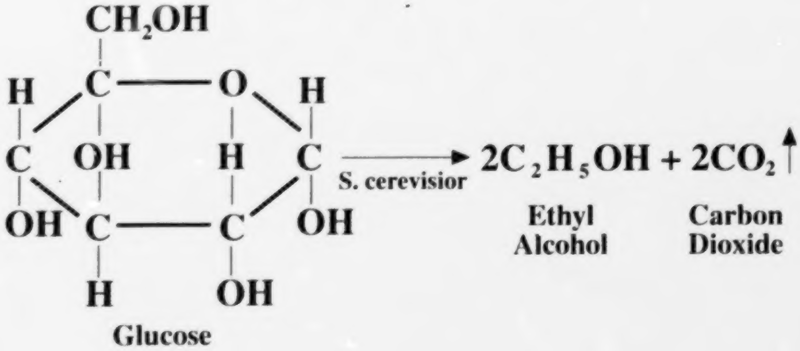
External off-color development may be the most obvious physical change caused by food deterioration. Meat exposed to fluorescent or incandescent light too long develops a brownish-red color. Meat color is determined by its predominant pigment, myoglobin. Myoglobin is a purple red pigment due to its iron constituents. When exposed to air, myoglobin adds two oxygen atoms and becomes oxymyoglobin. Oxymyoglobin is responsible for an intense red color. Oxygen permeable wrapping is preferred on meat cuts to promote this appealing color. If insufficient amounts of oxygen are available, however, oxymyoglobin oxidizes to metmyoglobin, a brownish-red pigment. Mold growth on the surface comes in a rainbow of colors. Some fruits, when stored at low temperatures may develop internal browning.

Chemical Changes

Chemical deterioration is due to a change in the chemical, or molecular structure, of food. Fermentation of sugars is a chemical change that, under controlled conditions, is a beneficial process in the production of bread, buttermilk, and yogurt. Fermentation can cause deterioration in uncontrolled environments. Fermentation splits a glucose molecule into two ethyl alcohol and two carbon dioxide atoms. (Figure 2.1)

Carbohydrates (starches) and proteins may undergo hydrolysis. Hydrolysis is defined as the splitting of a molecule by the uptake of a molecule of water. Corn syrup is produced by the hydrolysis of cornstarch with hydrochloric acid. The end product is called corn sugar. Hydrolysis of proteins is usually undesirable in foods.

Figure 2.1 - Fermentation



A third type of chemical reaction that can cause deterioration is called lipolysis, or the reaction of a water and fat molecule that releases a fatty acid in the presence of heat or the lipase enzyme. This process alters the flavor and aroma of fats or oils and creates a rancid odor.

Proteins also can denature, losing their unique structure. If the protein is an enzyme, it loses its ability to be a catalyst. Often a denatured protein is less soluble. Denatured proteins often coagulate. Think about what happens when you fry an egg. The proteins in the egg white denature when heating. The once clear liquid becomes an opaque rubber solid. Denatured proteins may be more easily digested by microorganisms resulting in development of undesirable flavors, odors, or textures.

Toxin production is the sixth chemical change resulting from food deterioration. A food intoxication results from a toxic substance being produced in a food item before consumption. Certain molds can produce mycotoxins, which are poisonous. One well known mycotoxin is aflatoxin. Aflatoxins may be found on moldy grains and peanuts. Ergot is a mold toxin that can cause hallucinations. It may have been responsible for the Salem witch trials.

Enzymatic reactions are the advanced stage of normal enzymatic reactions. While the plant or animal is alive, enzymes are busy catalyzing chemical reactions. These reactions are kept in control by the living system. However, when the tissue is dead, these enzymes continue to work and ultimately cause degradation. These chemical changes may be inactivated by heat, chemicals, and/or radiation.

Pigment conversion is an eighth example of deteriorative chemical changes. For example, as the green pigmented chlorophyll molecule in plants is transformed into the pheophytin molecule, the bright green is converted to greenish-gray and olive green. A magnesium ion is replaced by hydrogen. Similarly, the oxymyoglobin molecule in red meat is chemically changed to metmyoglobin.

Environmental Conditions for Bacterial Growth

Bacteria, along with yeasts and molds, prefer warm, moist growing conditions. Most bacteria are mesophilic. Mesophilic bacteria survive in temperatures ranging from 60°-100°F. There are also cold-loving (psychrophilic) bacteria, which survive at temperatures down to 32°F. Conversely, thermophilic bacteria can grow in temperatures up to 180°F. Because moisture is required for bacterial growth, a zero or very low water activity level is the reason why salted and/or dehydrated foods are not overcome by bacteria. Because there are aerobic and anaerobic bacteria, the need for oxygen depends on the type of bacteria.

Microorganisms that Contribute to Food Deterioration

An important point to remember is that microorganisms are generally not found within the living tissue of a healthy plant or animal. Milk, for instance, is sterile when secreted. Fruits, vegetables, grains, and nuts become contaminated when their protective skin or shell is broken or weakened.

Bacteria - Not all bacteria cause food spoilage. Many types of bacteria are used to preserve food, like the lactic-acid producing organisms of cheese, sauerkraut, and certain types of sausage. Others are used for flavor production.

Bacteria are found everywhere from the hides and feathers of animals, to shells of nuts, in the soil, water, and air, and on processing equipment that has not been sanitized.

Bacteria are unicellular organisms; they are cells without a nucleus, known as procaryotes. They are classified based on their shape: spherical shapes are cocci; rod shapes are bacilli; and spiral forms are spirilla and vibrios. Many bacteria move by means of a flagella, a whip-like tail. Others produce spores, which are seedlike and incredibly resistant to heat, chemicals, and other adverse conditions. Bacterial spores are more resistant than yeast or mold spores. They resist most processing conditions to a greater extent than natural food enzymes. Needless to say, sterilization processes are aimed at these bacterial spores.

Bacteria are small, one to a few micrometers (um) in length, and can penetrate the smallest openings. Most bacteria multiply at 60°-100° F, the temperature range of mesophilic bacteria. Recall, however, that psychrophilic bacteria multiply at very low temperatures while thermophilic bacteria can withstand very high temperatures. Some bacteria are aerobic, while others are anaerobic.

Bacteria multiply in an exponential fashion. Under favorable conditions, their numbers can double every 30 minutes.

Bacteria are also classified based on their staining characteristics. Gram-positive bacteria retain a dark violet or purple color after a purple dye/iodine mixture is applied followed by an alcohol treatment in an attempt to decolorize. Gram-negative bacteria lose the dark violet color after the alcohol is applied. The Gram method of bacterial identification is one of the most important methods used. While this method is not absolute, it does provide valuable information in determining which bacteria are present. Thus, a corresponding method of treatment or sanitation can be established.

Fungi - Fungi, or yeasts and molds, are also helpful/harmful agents in food science, depending on which specific ones are present. Yeasts are necessary in making bread, wine, and beer because of their fermentation qualities. Molds are used to ripen Danish blue, Roquefort, and Camembert cheeses. They are also used to manufacture soy sauce and citric acid. The mold penicillium produces the antibiotic penicillin.

Yeasts and molds are found everywhere and can cause food spoilage. Yeasts and molds like warm, moist growing conditions. Yeasts are larger than bacteria, around 20 micrometers in length. Most yeasts are spherical or ellipsoidal in shape. Yeasts reproduce asexually in the form of spores. Most yeast colonies are creamy white in color and slimy in appearance.

Molds are larger than yeasts and grow by hairlike fibers call mycelia. Mold spores create the blackness of bread mold and the blue-colored veins in blue cheese. All molds are aerobic.

Organisms That Can Cause Diseases

Camphylobacter - The camphylobacter bacteria are responsible for causing camphylobacteriosis, which is the leading cause of acute gastroenteritis (inflammation of the stomach and intestines) in humans. Only a few bacteria are required to cause illness. This bacterium has been found primarily in raw milk and poultry, but it has also been found in cake icing, eggs, beef, and contaminated drinking water.

Clostridium botulinum - Botulism is caused by these bacteria, which are present throughout the environment. The bacteria can be found in damaged canned foods and home-processed foods that were not properly processed. Also, other foods such as potato salad, sauteed onions, chopped garlic, raw cabbage, and hazelnut yogurt have been found to contain the botulism bacteria. Infant botulism can be caused by honey, which often contains botulinum bacteria. That is why it is recommended that infants not be given honey. The most common symptoms of botulism are fatigue and blurred vision. Few people have the usual gastrointestinal symptoms of food poisoning. Death is common for people getting botulism.

Escherichia coli - These bacteria, commonly called E. coli, live naturally in the human intestinal tract. They are responsible for causing diarrhea in infants and travelers. One uncommon strain causes two life-threatening conditions: hemorrhagic colitis and hemolytic uremic syndrome. Bacteria found in raw and undercooked ground beef and raw milk have been linked to these illnesses. The bacteria can be controlled by cooking meat thoroughly and keeping cooked meat away from uncooked meat.

Hepatitis A virus - The hepatitis A virus can be contracted from food not properly prepared by a person infected with hepatitis or from eating contaminated raw shellfish or contaminated mollusks. Cooking does not always kill the virus. Hepatitis symptoms at onset of illness include: malaise, appetite loss, nausea, vomiting, and fever. As the illness progresses, the patient develops jaundice with darkened urine, and may have liver damage.

Listeria - Listeriosis disease is caused by the listeria bacteria. While the bacteria, infect shellfish, birds, spiders, and mammals all over the world, it is uncommon in humans. Although there are not nearly as many cases of listeriosis as there are salmonellosis, it is a very deadly disease especially for fetuses, newborns, and people with weakened immune systems. People can get listeriosis by eating foods contaminated with the bacteria such as soft cheese, unpasteurized milk, seafood products, cooked shrimp, and cooked surimi (fish, sausage, artificial crab). The disease is also transmitted by direct contact with mud, sewage, or soils contaminated with the organism and by inhalation of contaminated dust particles. This tough bacteria can grow at refrigeration temperatures and can survive mild heat.

Salmonella - This bacteria causes salmonellosis. Very low levels of bacteria can cause this disease. More than 40,000 illnesses are reported each year, but experts believe there are many more cases that are not reported. Nearly half the reported cases of salmonellosis require hospitalization, and one to two percent result in death. The salmonella bacteria have been found on many foods, particularly on raw meats, poultry, dairy products, pasta, and chocolate. Symptoms range from none to very severe but most often include nausea and diarrhea.

Staphylococcus - Staphylococcal infections are caused by the staphylococcal bacteria. Staphylococcal bacteria are found in the nose and mouth and on the skin of healthy people. The bacteria multiply at warm temperature, which produces the toxin that causes illness. Infected people who prepare or handle food can spread the illness to others if proper hand washing and utensil cleaning are not followed. Also, the bacteria can multiply quickly if leftover food is not promptly refrigerated.

Toxoplasma - Cats frequently are infected with this parasite, which can be transferred to humans by contacting contaminated cat feces or by eating improperly cooked meat or poultry. The animals received the infection from infected cats. Infants can acquire the parasite from their mothers before birth. Severe mental retardation may result. Meat, particularly lamb and pork, should be cooked thoroughly to kill the parasite. Individuals with a weak immune system are particularly susceptible to toxoplasmosis.

Trichinella - This parasite causes trichinosis. It is commonly found in animals that eat human garbage. It is mostly transmitted to humans by eating undercooked pork or bear. Symptoms include abdominal pain, nausea, fever, diarrhea, muscle pain, and fatigue. There are few cases of trichinosis in the United States.

Vibrio parahaemolyticus - Vibrio parahaemolyticus bacteria cause vibrio gastroenteritis, which can cause water diarrhea, abdominal cramps, vomiting, headache, chills, and fever. This organism can be ingested in contaminated uncooked or undercooked shellfish. The bacteria can also enter the human body when an individual with open wounds comes in contact with infected coastal waters. A very closely related microorganism, vibro cholera also can be transmitted by seafood, salt water, but it is most commonly found in areas with poor water treatment facilities.

Yersinia - Yersinia bacteria cause the plague. The rat is the primary carrier. If an infected rat leaves droppings in grain, for example, those contaminated droppings could get into the food supply for humans, thus spreading the disease. Unproperly cooked pork or raw milk may have the Yersinia bacteria present. Yersinia can grow at refrigeration temperature, but heating kills the bacteria.

Using a thermometer when cooking meat can reduce the incidences of these food-borne diseases.

Summary

Foods are a perishable commodity. Foods are subject to both physical and chemical deterioration. Dehydration, a cracked skin, a broken emulsion, off-colors, and a change in the texture are all physical deterioration examples. Chemical reactions that lead to deterioration include fermentation hydrolysis, toxin production, enzymatic reactions, and pigment conversions. Moisture and warm temperatures are necessary for growth of bacteria, yeasts, and mold. Bacteria, yeasts, and molds are the organisms responsible for the majority of food deterioration. A variety of human diseases result from microbial invasion. Examples include botulism, salmonella, trichinosis, campylobacteriosis, etc.

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Lesson 3:
Nutritional Properties of Foods

Major Food Groups

A complete meal has five parts. Meats, breads and cereals (also called grains), fruits, vegetables, and dairy products are the five major food groups. Fats, oils, and sweets should be used sparingly.

Six Classes of Nutrients

The five food groups can be divided into six classes of nutrients. These essential nutrients consist of: carbohydrates, proteins, fats, vitamins, minerals, and water.

Figure 3.1 - Nutrient Classes

- Carbohydrates
- Protein
- Fats
- Vitamins
- Minerals
- Water

Carbohydrates are energy-rich compounds that supply the majority of the body's energy, or caloric needs. Carbohydrates consist of carbon, hydrogen, and oxygen atoms in a $C_1H_2O_1$ ratio. Sugars, starches, and plant fibers provide carbohydrates with glucose, a monosaccharide, being the simplest form of carbohydrate.

Protein supplies the body with molecules that contain nitrogen. Eight essential amino acids are the building blocks of protein and consist of: leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine, along with histidine for childhood growth.

Fats (also called lipids), are the most energy-rich compounds. They provide necessary fatty acids for normal metabolism. They are also needed for transporting fat-soluble vitamins.

Vitamins are organic molecules that are needed in small amounts but can make big differences in one's health. Vitamin D can be synthesized by a healthy body, while the remaining vitamins must be supplied in the diet. At times, Vitamin D may also need to be a part of the diet to meet necessary levels. Vitamins are broken into two groups: fat-soluble and water-soluble. Vitamins A, D, E, and K are fat-soluble, while vitamins C and B complex are water-soluble.

Minerals are inorganic molecules needed in small amounts. The major minerals include Calcium (Ca), Phosphorus (P), Magnesium (Mg), Cobalt (Co), Sodium (Na), Chloride (Cl), Potassium (K), and Sulfur (S). The trace minerals consist of Selenium (Se), Fluorine (F), Iodine (I), Iron (Fe), Zinc (Zn), Copper (Cu), Manganese (Mn), Chromium (Cr), and Molybdenum (Mo).

Water is also a necessary nutrient. A person may survive several days, possibly weeks without food. However, without water, you can live only a few days.

Nutritional Characteristics

Meats are a primary source of protein. They also contribute carbohydrates, fats, vitamins, and minerals.

Breads and cereals are a primary source of carbohydrates. They also contribute protein, fat, vitamins, and minerals.

Fruits are a primary source of vitamins and minerals.

Vegetables are a good source of minerals and vitamins. Carbohydrates and protein are also supplied by fruits and vegetables.

Dairy products are excellent sources for all nutrient categories.

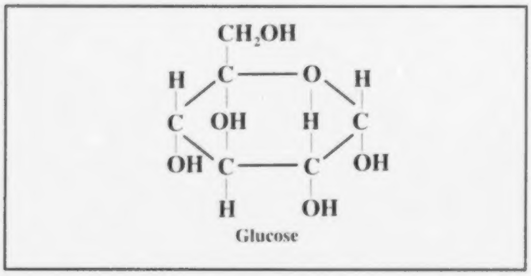
Fats and Sweets - Foods containing high amounts of fats and sweets tend to have very limited amounts of essential nutrients (vitamins, minerals, and protein). They are sometimes called empty calories.

Functions of Each Nutrient Class

Scientists use the terms "Kilo-calories" and "calories" in their discussions about nutrition. A Kilo-calorie (Kcal) is 1000 calories. One calorie (with the lowercase "c") is the amount of heat (i.e., energy) needed to raise the temperature of one gram of water one degree Celsius. Frequently, "Calories" with an uppercase "C" is used to indicate the number Kilo-calories in foods. Technically, these Calories are actually Kilo-calories. Throughout the discussion of nutrition in this manual, the number of Kilo-calories in a food will be identified as Calories.

Carbohydrates supply 4 Calories per gram of energy. Ninety-eight percent of sugars and starches are digested and fully oxidized into cellular energy. Carbohydrates are needed for body heat, tissue synthesis, and energy for work and play. Carbohydrates also supply carbon, which helps the body use fat efficiently, spare proteins from being converted to a major energy source, provide fiber, and promote vitamin B synthesis. Complex carbohydrates are long-chain molecules of glucose.

Figure 3.2 - Glucose Molecule



Proteins provide 4 Calories per gram of energy, but are only 70 percent digested and oxidized, on the average. Their primary roles are to supply nitrogen-based molecules necessary for tissue synthesis and to provide the essential amino acids needed for enzyme production. A complete protein contains all eight amino acids: leucine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, plus histidine for childhood growth.

Animal proteins are complete. Plant proteins are incomplete, meaning they are missing at least one of the essential amino acids. Most wheat, rice, and corn grains lack lysine. Legumes lack methionine. A lack of protein in early childhood can lead to retardation. A critical point is not how much protein is consumed, but rather a combination of the amount and the quality. Not all protein is digestible or palatable. A raw soybean is not digestible, but a processed soybean is digestible.

Fats provide 9 Calories per gram of energy. Approximately 95 percent of this is digested and oxidized. Fats provide essential fatty acids to the human diet. Linoleic acid is one essential fatty acid that promotes normal growth and prevents skin disorders. Research also suggests that linoleic acid, when present in high proportions compared to other dietary fats, may lower blood cholesterol. Dietary fat allows vitamins A, D, E, and K to be transported and absorbed. Fats contribute to phospholipid production and function. They help insulate and protect the body and store excess energy.

Vitamins serve a required function in enzyme systems which metabolize proteins, carbohydrates, and fats.

Vitamin A, or retinol, occurs only in foods from animal sources. Plants do contain beta-carotene, which is a precursor to vitamin A. Beta-carotene can be converted to vitamin A and is found in orange, yellow, and green leafy vegetables. A deficiency in vitamin A can lead to night blindness, abnormal bone and tooth development, or diseases of the epithelial cells.

Vitamin D can be formed in an animal's skin by ultraviolet sunlight activating cholesterol or ergosterol. Eggs, dairy products, liver, and fish oils are good food sources of vitamin D. This vitamin increases the absorption of calcium and phosphorus from the intestinal tract. A lack of vitamin D can lead to a bone defect condition.

Vitamin E favors iron absorption and serves as an antioxidant, which spares vitamin A and carotene from oxidation. Vegetable oils are good sources.

Vitamin K is essential for normal blood clotting and is prevalent in cabbage and spinach.

Vitamin C, or ascorbic acid, prevents scurvy, bone joint diseases, teeth loosening, and fragile capillary walls. It is needed for normal protein collagen formation. It favors iron absorption. Good sources are citrus fruits, tomatoes, cabbage, and green peppers.

Nine specific B vitamins make up the B complex group. All are abundant in liver, yeast, and cereal grain bran. Thiamine, or B_1, is needed to oxidize glucose. Riboflavin, or B_2, is needed for cellular growth and tissue maintenance. Niacin is used for tissue respiration and oxidation of glucose. B_6 is needed for enzyme systems. Pantothenic acid is needed for mental health. B_{12} helps prevent anemia and is required for nucleic acid formation. Folacin also helps prevent anemia and is required for nucleic acid formation. Biotin helps metabolize fatty acids and amino acids.

Several minerals are necessary for growth and metabolism. Calcium (Ca) is needed for blood clotting, bone and tooth development, enzyme function, and to control fluid movement through membranes. Phosphorus (P) is required for normal metabolism, acid alkaline blood reactions, and phospholipid production. Milk and dairy products are excellent Ca and P sources. Magnesium (Mg) is required to help metabolize Ca and P for muscle contractions, electrical potential in nerves, and enzyme systems.

Iron (Fe) is needed for blood hemoglobin, the O_2 carrier, and muscle myoglobin, the O_2 storehouse. Iron is abundant and readily available in red meat. Copper (Cu) helps manufacture hemoglobin and aids in iron utilization.

Cobalt (Co) is a part of vitamin B_{12}. Zinc (Zn) is needed for enzyme production. Sodium (Na) is needed for osmotic equilibrium and body fluid volume regulation. Chlorine (Cl) exists as the chloride ion and is used to produce hydrochloric acid.

Potassium (K) is used to regulate osmotic pressure, equilibrium, and pH. Cellular enzymes need potassium.

Iodine (I) is needed for thyroid hormone production. Fluorine (F) prevents tooth decay. Manganese (Mn) is needed for bone structure, central nervous system function, and reproduction. Chromium (Cr) is used for glucose metabolism. Molybdenum (Mo) is required for protein metabolism.

Water is a vital nutrient although its functions are often overlooked. Besides comprising about 60 percent of a human's body weight, it serves as a chemical solvent for reactions in the body, it transports media to cells, removes body waste, regulates body temperature, and is essential for a controlled metabolic rate.

Nutrient Sources

To list every source of the six nutrients would require a listing of every food source known to man. Rather, an abbreviated list of foods that are particularly rich in a specific nutrient follows.

Carbohydrates come from potatoes, rice, flour, and dairy products.

Protein is found in meat, poultry, fish, eggs, legumes, and dairy products.

Fats are found in meat, poultry, grain oils, nuts, and dairy foods.

Vitamins come in fruits, vegetables, and dairy products.

Minerals are obtained from meat, fruits, vegetables, and dairy foods.

Water comes in beverages and high water-content foods.

Summary

Meats, breads and cereals, fruits, vegetables, and dairy products are the five main food groups. The body digests these foods into six major nutrient categories: carbohydrates, proteins, fats, vitamins, minerals, and water. Each nutrient serves an essential role in the body's health. These nutrients are found in a variety of food sources and are essential for a healthy diet.

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Lesson 4:
Processing Influences Nutritional Value

This lesson will examine four variables that can cause food to lose part of its nutrients during processing. The enhancement of food nutrients will likewise be examined.

Temperature Affects Nutrient Availability

Consumers who are nutrition conscious realize that purchasing nutritious food is only the first step in a healthy diet. The manner in which this food is stored and prepared determines the nutrients that will be available when the food is eaten. Temperature is one such variable. The organic nutrients: carbohydrates, fats, proteins, and vitamins, contain enzymes that are constantly being produced and then degraded. When, for example, a peach is harvested its natural enzymatic activity begins to degrade tissue. At room temperature, a significant vitamin loss could occur. Therefore, chilling is necessary to slow the enzymatic processes. Another control for fruit and vegetable enzyme activity is blanching. Blanching or boiling briefly stops enzymatic activity.

High temperatures can likewise be detrimental to proteins. Proteins tend to toughen when exposed to high temperatures. But they are usually more easily digested after heating. High temperatures and long cooking times tend to destroy vitamins.

Light Affects Nutrient Availability

Fluorescent light and the ultraviolet rays of the sun can destroy riboflavin in foods. It is for this reason that milk is no longer retailed in transparent glass containers, but rather it is sold in opaque plastic or cardboard. Vitamins, in general, are susceptible to light breakdown.

Water Content Affects Nutrient Availability

Foods that have a high water content need to be prepared in a different manner in order to preserve their nutrients. Vegetables that are cooked in water can lose nearly one-half of their water-soluble vitamins to the water. It is for this reason that steaming vegetables is often suggested. If food is to be prepared in water, think of ways to use the "pot juice," like in soup or to cook rice.

Oxidation Affects Nutrient Availability

Oxidation is the chemical reaction that takes place in the presence of oxygen. When it is controlled in the body cells, oxidation results in the breakdown of nutrients and the release of energy. However, when foods are overcooked, burned, or charred, nutrients are oxidized to carbon and oxygen gas and are not available for digestion. Protein molecules release nitrogen as N_2 or Nitrous oxide. Similarly, fruits that have been exposed to air and are dried out have lost some of their nutrients. For example, vitamin C is lost from oranges. Transition BHA and BHT are commercial antioxidants. Vitamins C and E are natural antioxidants.

Processes Used to Enhance Nutritional Value

The twentieth century has seen a nutritional revolution. Modern processes were invented to convert wheat into white bread rather than the standard whole wheat bread. This process, and similar ones, produce foods that are more pleasing to the taste buds; however, some nutrients may be reduced or even eliminated. The Enrichment Act of 1942 standardized the return of necessary nutrients to commercial flour. Enriched bread was supplemented with iron, niacin, thiamin, and riboflavin. Scores of food products today are enriched. Table 4.1 compares whole wheat spaghetti pasta, spaghetti pasta-enriched, and spaghetti pasta-unenriched.

Another means of nutrition enhancement is called fortification. This is very similar to enriched foods except that fortified foods have added nutrients that may or may not have originally been there. Examples of fortified foods include milk fortified with vitamins A & D, salt with iodine, and soft drinks with added vitamin C or calcium.

Nutritional supplements are slightly different from fortified foods. Supplements contain nutrients, usually vitamins and minerals, in amounts greater than 50 percent of the RDA. The most common form of supplements are vitamin pills, but many sport drinks are now on the market that could be considered to be supplements.

Table 4.1 - Nutrients in 2 oz Serving of Dry Spaghetti Pasta - % Daily Values*

Type of Spaghetti Pasta	Iron	Calcium	Thiamin	Riboflavin	Niacin	Vitamin B	Folacin	Fiber	Fat
Whole Wheat	10%	2%	20%	6%	15%	6%	8%	25%	1%
Enriched	15%	2%	40%	15%	25%	4%	2%	10%	1%
Unenriched	4%	2%	4%	2%	6%	4%	2%	6%	1%

*Based on 1994 USDA Percent Daily Values

Sometimes foods have been fortified or supplemented with vitamins and minerals because the addition of these vitamins and minerals may be needed to help the body utilize vitamins and minerals naturally occurring in the foods. For example, vitamin D increases the absorption rate of calcium and phosphorous.

Many processing techniques are useful in maintaining nutrients. These range from quick cooling fresh fruits and vegetables to proper cooking temperatures and cooking length. Some types of produce are waxed or packaged to prevent dehydration.

Summary

Temperature is an important environmental variable that determines the nutrient availability of food. Organic molecules break down faster at high temperatures than at low temperatures. Fluorescent lights and ultraviolet rays break down riboflavin. High water content foods are likely to loose many of their nutrients when boiled or cooked in a liquid. Oxidation decreases levels of many vitamins. Careful control of storage and processing conditions is necessary to assure the maximum nutritional value of food products.

Enrichment and fortification may be used to enhance the nutritional status of food. Occasionally foods are formulated to contain relatively high levels of individual nutrients. These foods are called supplements.

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Lesson 5:
Biotechnology in the Food Industry

In the food industry, biotechnology has likely made an impact on food you have consumed. This lesson will define biotechnology, examine its effect on food production, discuss examples of bioengineered foods, and look at biotechnology's future.

What is Biotechnology?

Biotechnology can be defined in many ways. The use of microorganisms, animal cells, plant cells, or components of cells such as enzymes to produce products or carry out processes for human benefit is the detailed definition. A more concise way of defining biotechnology may be the use of living organisms or their enzymes to make commercial products.

Biotechnology's Effects on Food Production

People using principles of biotechnology have made dramatic impacts on global food production. A greater variety of foods is the first result. A tangelo is a bioengineered hybrid between tangerine and grapefruit trees. Potatoes prefer cool climates, but may soon be produced in hot, humid climates. Soybeans are one of the brightest stars of current food biotechnology research.

A second result of biotechnology's effect on food production is the increased shelf life/safety of food. Food preservatives and fermentation are some of the areas in which food scientists have applied biotechnology toward food safety and shelf life enhancement. This area holds great promise in reducing the need for synthetic pesticides and food additives.

Another area of biotechnological advances has been harvested to benefit greater efficiency in food production. Crop production benefits from biotechnology produced fertilizers, pesticides, genetic-engineering, and hydroponics. Animal agriculture benefits from new vaccines, nutritional advances, embryo transplant programs, feed additives, and growth hormone research.

Bioengineered Foods

One only has to browse through a grocery store to find hundreds of food products that are a result, to some degree, of bioengineering. Enzymes, low-calorie foods, waste management, biological monitoring, casings, and insulin will be evaluated in this section.

Rennet and lactase are enzymes used in the dairy fermentation industry. Naturally, the enzyme rennet is used to coagulate casein during cheese-making, and is consumed in each batch. Bioengineered, immobilized rennet improves its stability and allows easy separation from the cheese, thus it can be recycled and reused. Lactase cleaves lactose to glucose and galactose. It too can be immobilized and recycled.

Low-calorie foods may contain non-nutritive sweeteners like aspartame, thaumatin, or monellin. These compounds are taste active proteins. The genes that code for these compounds may be isolated and transferred to non-harmful bacteria. Since bacteria reproduce so quickly, bacteria with these sweetener genes can be added to food products in a fermentation process and transfer the taste. Low-calorie foods are also one of the goals of soybean and rapeseed research. By reducing the oil content of the seed, more protein would be produced per seed. Genetic engineering may soon produce extra-lean pork and beef carcasses, resulting in red meat that fits better into a healthy diet.

In waste management, the waste from food processing, particularly the whey from cheese making, can be consumed by a bioengineered yeast. This particular yeast produces a grape aroma and could be used as a flavor component in the wine and food industries.

Biological monitoring is another prospect for bioengineered foods. DNA fragments from disease-causing microbes can be coded, isolated, and hybridized to detect the presence of the same microbe in food.

Bioengineering is responsible for manufactured casings used as a substitute for natural casings. Cellulose casings are produced from cotton lint and paper pulp. Collagen casings are made from the inedible portions of the beef carcass.

Businesses Involved in Biotechnology Research

Anyone who has been involved in selective breeding programs has been involved in biotechnology. However, the new technologies that allow scientists to work at the cellular or chromosomal level require expensive equipment. Major advances in biotechnology have been the result of the cooperative efforts of many business enterprises.

The United States Department of Agriculture (USDA), universities, food processing companies, commodity organizations, the National Live Stock and Meat Board, and other food related companies are active in biotech research.

Future Influence

The Green Revolution, which is the widespread adoption of high-yielding grain varieties along with an expanded use of fertilizers and irrigation, started in the late 1960's. Will the Green Revolution continue? As long as there are hungry people to feed, science and agriculture will continue to strive to feed them. The need for better weed control, less insect damage, enhanced nutritional quality and safety, greater disease resistance, and improved genetics will fuel the machine to continue the biotechnology revolution. Look for a longer shelf life, new vaccines, less dependence on petroleum-based oil, further advances with soybean- and corn-based products, a greater dependence on biological control of insects, and new resistant varieties of fruits and vegetables. Herbicide-resistant corn, greater reliance on hydroponics, possibly grasses that fix their own nitrogen, soy-based coatings to keep food from dehydrating or oxidizing, and natural antifreeze sprays to prevent citrus trees from freezing are just a few samples of what the future may hold. Herbicide-Resistant Corn is a genetically engineered corn variety that is tolerant to previously lethal herbicides.

Factors Influencing New Developments

To name every factor that may influence new developments in food biotechnology would be similar to forecasting next year's weather. Some factors are known while several remain unknown.

Generally, the greatest need receives the most attention and effort. "Where there is a will, there is a way" is the old saying. If there is semi-drought growing conditions in the Midwest for five consecutive years, drought-resistant crops will be developed and planted. If a new strain of grasshopper invades the South, a new insecticide will likely be developed.

Finances always play a role. Research takes money, whether it is federal, state, or private funds. The need for talented, committed, educated researchers will need to be met. Biotechnology takes some specific facilities and equipment. The weather will play a part in research of plants, insects, animals, etc. Time is also a factor. New releases must be thoroughly tested before release. The Food and Drug Administration and Environmental Protection Agency require extensive testing.

Summary

The biotechnology revolution will continue to make major impacts on human lives. The use of microorganisms, animal cells, plant cells, or components of cells such as enzymes to produce products or carry out processes for human benefit will increase in the future. Whether it is protein derivatives; resistant varieties, or low-calorie foods, biotechnology will continue to impact a growing population.

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Lesson 1:
Factors that Affect Consumer Choice

What do food producers and grocers have in common? They work together to provide the consumer a wholesome product that is a good value. Because the consumer has the right to accept or reject any food item, producers and grocers must work together to influence consumer choice. This lesson focuses on the factors that affect consumer choice.

Factors Affecting Consumer Choice

There are several factors that play a part in helping the consumer decide what food selections to make. The location in which you live may determine your food supply. Small rural grocers are less likely to carry exotic food items, whereas a large supermarket may carry almost everything. The cost of food obviously is a factor. The time of day in which the consumer is shopping helps make some food choice decisions. A ready-to-eat meal is a priority when the shopper is hungry. The shopper who is planning ahead may select the raw ingredients to make the meal.

The consumer's knowledge and skill help determine what is purchased. A more knowledgeable consumer purchases more balanced and nutritious foods. Energy is the fifth consideration. Not only is the energy to prepare the food a concern but also the amount of energy the shopper has while grocery shopping.

Other people play a big part in the quantity of food purchased. A person's emotions will influence what is purchased. When a certain athlete's picture is on a box, admirers are more likely to purchase it. The first items that are encountered in a grocery store also appeal to the emotions. The tools or equipment the consumer has at home also determine what foods will be purchased. Without a microwave oven, why buy microwavable popcorn?

A person's culture also plays a role in his/her diet. Many consumers buy food that fits their culture. Religion determines some people's diets. No red meat on Fridays during lent, no meat at all, and no pork are all dietary restrictions based on different religious views. Advertising influences consumers to purchase foods. The products found in newspaper advertisements are commonly high volume items. A person's lifestyle greatly affects their selection. High energy diets are necessary for active people. Less active people require fewer calories. Finally, a person's values influence selection. The growing segment of the population who avoid alcohol and the shopper who compares different package sizes of the same products are all basing their decisions on their value systems.

Sensory Attributes

Why is parsley used to decorate a steak meal? Because people are drawn to attractive food. The color of a food and/or its packaging helps sell that product. Eyes are also drawn to what they perceive to be ideal sizes and shapes of food, or whose picture is on the package. Processors take advantage of the sense of eyesight.

The second sensory attribute that is used to make sales is the smell or odor of a product. Can you imagine walking past a bakery that is emitting the delicious aroma of fresh baked bread? How would the popular hickory smoke BBQ influence a customer's buying habits?

The third sensory attribute of food is the sense of taste. Different tastes satisfy different taste buds. Foods are made sweet, sour, salty, or bitter to satisfy the specific taste desired.

The texture or feel of a product may also influence purchase decisions. Soft bread, crisp celery, and firm apples are considered desirable texture characteristics by most consumers.

Convenience Affects Selection

Most people do not enjoy washing dishes. This seems to be one of the reasons why people buy convenience foods. Time, energy, clean-up, variety, and equipment all influence consumers to purchase convenience foods. Today, many people are rushed for time. Convenience foods are easy to prepare. It takes energy to plan a meal, shop for it, and prepare it. Convenience foods save most of the energy required to make a meal from scratch. There is little clean-up with convenience food. Variety may induce a consumer to choose convenience. Food leftovers, especially for single-person households, may be the main course too often. Fast food businesses and other restaurants can provide a person with variety. Also, it may take special equipment to prepare foods such as deep-fry or grilled foods. Many convenience-food businesses already have these tools. These five reasons help explain why convenience food is steadily growing.

Not every shopper is a convenience food fan, however. Consumers who believe that slower food preparation or only using fresh or home-grown produce is more nutritious, may be negatively influenced by convenience food advertisements. Another reason why fast foods are not purchased may be because of their high cost relative to a home-cooked meal. If the home-cooked meal is entirely consumed, without spoilage, it is normally cheaper to prepare the meal in the home. Also convenience foods may have more packaging which results in increased disposal costs.

Price's Influence

Price has always been a deciding factor for consumer food selection. Many grocers stock two or more brands of each food type to offer shoppers a variety of brands at a variety of prices. Smart shoppers are careful to examine not only the cost of a food product, but also its nutritional content. Impulse buyers are less likely to be influenced by price.

Packaging's Influence

Food processors have studied consumers' buying habits and realize that packaging definitely affects consumer choice. Labeling claims, "environmentally-friendly," size, and the cost of packaging are four factors that need to be examined.

Current trends reveal that foods low in fat or calories are usually packaged with a label proclaiming in bold letters "fat free" or "just 1 calorie." The Nutrition Facts Panel list is another catchy design, not to mention a star athlete's picture or "free offer inside" approaches. Environmentally-friendly packaging frequently influences consumers. If recyclable paper or biodegradable plastics are used, stewardship-minded consumers will respond positively.

Thirdly, the size of the package can exert an influence. Those family-size packages are great for families, while single-person households shop for smaller packages. Lastly, the cost of packaging plays a part. Current statistics indicate that up to one-third of a food product's cost comes from its packaging. For example, fruits and vegetables sold in bulk with the shopper doing the packaging are cost-savers. On the other hand, resealable lunch meat packages cost more but help maintain freshness. Different packages are beneficial in different situations.

Shelf Life

In general, the longer the shelf life of a product, the more flexibility the grocer and consumer has. Dairy products that spoil within a week are a high risk item to carry. In general, consumers desire fresh foods. Shelf life is extended with frozen, canned, cured, and dried foods.

Safety Concerns

To describe the average consumer's approach to food safety would be a difficult task, for there is a wide spectrum of concern. Most shoppers, when asked, would voice concern over the safety of the food supply. However, when observing consumer's habits, a slightly different picture is painted. More and more people rely on other people to prepare their meals with little knowledge of the cleanliness of the restaurant's kitchen. Safety-conscious shoppers are a growing rank. They can be found carefully examining produce for blemishes, canned goods for dents, and packaged foods for broken seals.

Nutritional Concerns

"You are what you eat" is a popular saying. Nutritious, wholesome food is the goal of most consumers and producers. Today's smart consumers are probably more nutrition-minded than ever before. Fat content, calories, additives, minerals, vitamins, fiber, and cholesterol are factors related to food quality. Skilled consumers select foods that combine the necessary elements in the right balance to provide for healthy living.

Summary

Choosing wholesome food that will provide a balanced diet is an important task. Consumers are influenced by a variety of factors in their attempt to reach this goal. Factors such as location, time, energy, cost, skill level, advertising, values, and emotions are just a few of the influences on consumer choice. The sense of sight, smell, and touch play a role in selection also. Convenience foods offer an alternative that, depending on your perspective, is a positive or negative influence. Most consumers are price conscious as well as skilled in package selection. Shelf life is directly proportional to value. Safety concerns are slowly growing and are usually voiced when questioned. Likewise, nutritional concerns are in the forefront and heavily influence the labeling of food items.

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Lesson 2: Interpreting the Food Label

You may be familiar with the old saying: You can't judge a book by its cover. However, for a food product, the cover says a lot. By careful analysis of the food label, you can get information about what is inside, how much is there, what ingredients were used to make the product, and finally how nutritious the product will be to eat.

Many people believe that information on the food label is false and misleading. If the information is false or misleading, then officials from the Food and Drug Administration and the Federal Trade Commission would put the food scientists in jail for mislabeling the product. The food labeling law requires that everything on the label be the truth. However, a discerning consumer can spot efforts at misdirection and confusion on some food labels.

In 1990, Congress passed the most comprehensive food labeling law in the world. This law is known as the Nutritional Labeling and Education Act of 1990. Included in this law were changes in many elements of a food label. These changes were designed to assure that the consumer would have access to accurate, easily understood information. Hopefully consumers will use this information to improve their eating habits. This in turn should improve health, reducing costs paid to physicians and hospitals to take care of people who did not eat correctly.

Parts of the Food Label

A food label is divided into two parts. The largest part, at least 40% of the total package area is known as the principal display panel (PDP). This is the part of the label that the consumer is most likely to see when the package is placed on the grocery store shelf. Thus, it may be the top of an ice-cream carton, or the large side panel of a box of cereal. The PDP must contain information to identify the food, either by a real name (*e.g.,* green beans) or a made-up name (*e.g.,* Cherrios). If a picture appears, it must look like the food in the box. Sometimes, if the food will require cooking before eating, the picture may say "serving suggestion." This says that it requires some additional work to get the product to look like it does on the package. The PDP must also state how much of the product is in the container, usually reported as net weight. The net weight is the weight of the food in the container, minus any liquid or other component that would not normally be consumed. The net weight must be reported in avoirdupois (ounces, pounds, and gallons) and metric (grams and milliliters) units.

The second part of the food label is the information panel (IP). The IP is the part of the label that is immediately to the right of the PDP. There are three elements that must appear on the IP. These include the name and address of the manufacturer, a list of ingredients, and a nutrition facts panel. The address must be present so that a consumer could get additional information about the product, or complain if they wanted to. The list of ingredients must be in order by descending weight. That is, the ingredient present in the greatest amount appears first, then the next greatest amount and so on until all ingredients are listed. There have been many changes in the ingredient listing so that consumers can know what they are eating. The original source of ingredients is sometimes listed, such as "animal fat" or "protein from soybeans." This allows consumers to avoid animal products for religious reasons or soybeans because of allergic reactions for example. They can carefully read the ingredient statement and discover what raw products were used in the food. Artificial ingredients are identified as such in the ingredient listing.

Finally there is the nutritional facts panel. In a very few instances, the nutrition facts panel may be omitted, but all of the other elements must appear on every food product offered for sale to the public. To understand the nutritional facts panel, we must understand something about the way nutrition information is being made available to the average consumer.

Daily Dietary Requirements

While some people may say they live to eat, in reality all people eat to live. Our body cells need a constant supply of many different elements to use as building blocks. Sometimes, these cells need entire molecules to do their functions. These elements and molecules are supplied by the food eaten. Since most people do not want to do a complete chemical analysis before every meal, nutritionists usually talk about food groups and serving sizes. These are easily estimated by most people. Correctly understanding the food groups will be helpful in planning a healthy diet.

Nutritionists and other scientists working for the USDA have classified foods into six groups. Five of the groups are: 1) bread, cereal, rice and pasta; 2) fruits; 3) vegetables; 4) meat, poultry, fish, dry beans, eggs and nuts; 5) milk, yogurt and cheese. The sixth group is called the fats, oils, and sweets. This group of food products provides few of the building blocks necessary for proper function of the body, so it is not generally considered a food group. To maintain optimal health, it is necessary to eat some of all of the five food groups each day. But how much?

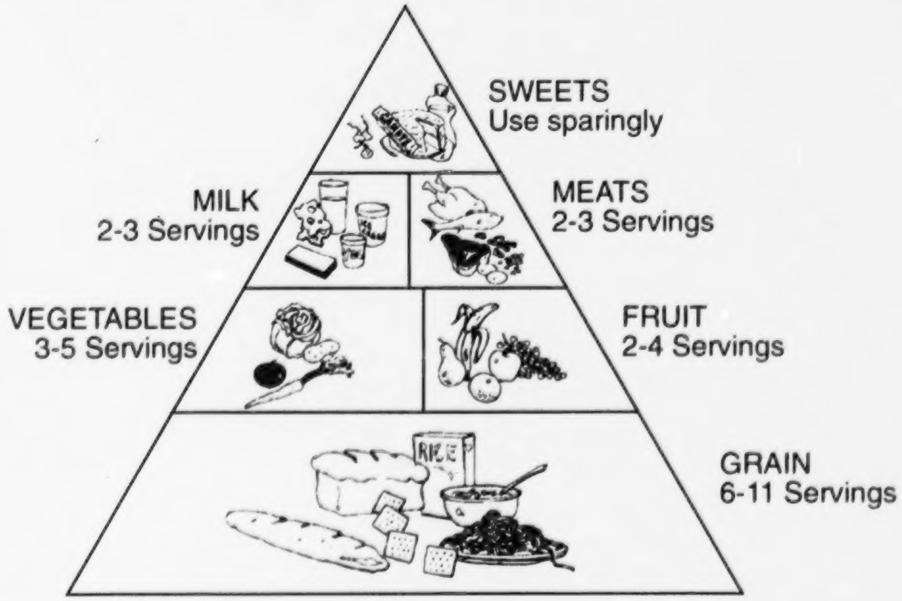
To help organize these groups in your mind, the USDA has developed a food pyramid (Figure 2.1). The size of each food group block in the pyramid represents how much of each group you should eat each day. For example, the bread group is the largest block, and is located on the bottom of the pyramid. The bread, cereal, rice, and pasta group of foods should serve as the foundation of your diet. Depending on several factors, including your age, sex, and weight, you should eat between 6 and 11 servings of these foods each day. While there are some exceptions, a serving of a food is generally about one-half cup. The foods in the bread group provide the carbohydrates needed for energy, many water-soluble vitamins, and trace minerals needed for proper cell function.

The fruit group and the vegetable group provide many vitamins that the body needs. The milk group provides calcium, vitamins and protein, while the meat, poultry, dry beans, eggs and nuts group provides protein and some vitamins. By combining foods from all these groups every day, you will be more assured of eating a healthy diet.

Nutrition Facts Panel

Many people eat foods in which the food groups are combined. Consider a pizza. It contains food from the bread, vegetable, milk, and meat groups (sometimes even the fruit group!) How many servings of each are in a slice? This is why the food label contains specific information on

Figure 2.1 - Food Pyramid



individual nutrients important in the American diet. To make things simpler, the nutrient content of foods is reported in both grams and Percent Daily Value. The Nutrition Facts panel includes total calories, calories from fat, total fat, saturated fat, cholesterol, sodium, total carbohydrate, dietary fiber, sugars, protein, vitamin A, vitamin C, calcium, and iron. (Figure 2.2)

Figure 2.2 - Nutrition Facts Panel for Thick Crust Pizza

Nutrition Facts

Serving Size 1/2 of 10" pie (208 g)
Servings Per Container 2

Amount Per Serving

Calories 480 Calories from Fat 90

	% Daily Value*
Total Fat 10g	**15%**
Saturated Fat 4.5g	**22%**
Cholesterol 25mg	**9%**
Sodium 1100mg	**46%**
Total Carbohydrate 76g	**25%**
Dietary Fiber 4g	**15%**
Sugars 10g	
Protein 24g	

Vitamin A 20% • Vitamin C 6%
Calcium 35% • Iron 15%

* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower based on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65 g	80 g
Sat Fat	Less than	20 g	25 g
Cholesterol	Less than	300 mg	300 mg
Sodium	Less than	2,400 mg	2,400 mg
Total Carbohydrate		300 g	375 g
Dietary Fiber		25 g	30 g

Calories per gram:
Fat 9 • Carbohydrate 4 • Protein 4

The Percent Daily Value assumes a 2000 calorie per day diet. This is the average calorie needs for most American women. (Men usually need about 500 calories more per day to maintain their weight.) Not all nutrients have to appear on a nutritional label. To keep the label simple, only nutrients known to be a problem for Americans are required to appear on the food label. In the American diet there are some nutrients that people should be sure to eat, such as carbohydrates, dietary fiber, and some vitamins and minerals. There are other nutrients that are important, but it is so easy to get enough of these that they are not included on the label. Unfortunately, there are some nutrients that Americans eat too much of, such as fat, cholesterol, and sodium. The amount of each nutrient in a specific food is calculated as a percentage of the total amount of that nutrient that should be consumed each day. By keeping track of the percentage of each nutrient consumed, when 100 percent is reached, you will know that you have gotten enough (of things like carbohydrates, dietary fiber, and vitamin C) or that you should not eat any more (fat, cholesterol, or sodium).

You may wonder why the daily value for protein does not appear on some labels. The first reason is that proteins have different quality. Foods like meat, eggs, and milk have very high quality protein, while other products like gelatin are very low quality. Other foods like grains, need to be combined with legumes (dry beans) in order for the protein to be of high quality. This would be very difficult to express on the food label. Since protein amount and quality is not a problem for most Americans, the daily value is not required. When you see a daily value for protein on a label, the value is adjusted for the protein quality.

The serving size on a food label is determined by comparison to a standard serving size. Serving sizes were found in a US government survey by interviewing thousands of people all over the United States. This is not necessarily the same serving size that is used on the Food Pyramid, but it is based on real amounts of food consumed at one meal by many Americans. The actual serving size on a label must compare to the standard serving size, the size of the package, and the weight of the food itself. It is a complicated process, but it is designed to make it easier to compare similar foods while shopping.

Unless you have an identical twin, there is no one else in the world exactly like you. Just as people look different, their nutritional requirements are different. It would be impossible to put all of the information necessary to figure out one's exact nutritional needs on every food label, so the information there is only an average for all Americans.

If a person wants to be more specific, he/she can use the information about the grams of each nutrient to calculate specific nutritional requirements. The information necessary to do this is included in the bottom portion of the food label, called the footnote section (see Figure 2.2). Additional information on the changing nutritional requirements for different ages can be found in almost any textbook on nutrition.

Most people are better nutritionists than they might think. As long as people eat a broad variety of foods, in moderation, the body does a good job of selecting what it needs, and disposing of the rest. Nutritional health is decided in the average over a long time, not just what you eat each day. For example, if you "pig out" on a high fat pizza today and get 200 percent of Daily Value for saturated fat you may think your diet is ruined. By limiting your intake of saturated fat from other foods over the next few weeks, there will be no harm done. However, if you consume 200 percent of the Daily Value every day for several months, you probably will find that you have gained a few unwanted pounds and may be at greater risk for heart disease and cancer in the future.

Nutrition, like most sciences, changes almost daily. At universities and research institutes all over the world, scientists are struggling to understand the role of food in health and disease. This means that nutritional recommendations may change as new evidence is uncovered. The food pyramid and the food label reflect the knowledge gained over the past 100 years, and are unlikely to change dramatically in your lifetime. But you never know.

Nutrient Level and Health Claims

Until 1990, words like "lite," "high," "low," and "good source "of" on a food label were hard to understand. There were no standards so food companies could use anything they wanted. Now these words, known as nutrient content claims, are defined by comparison to the Percent Daily Value. Foods that are "good sources" of a nutrient must contain at least 10% of the Daily Value for a nutrient per serving. Foods that are "high" must contain at least 20% per serving. There are similar rules for other descriptors such as lite, low, and free.

Usually foods that contain high levels of fat, sodium, or cholesterol may not claim to be a good source of some other nutrient. It is very complicated for a food company to be sure they can make a nutrition level claim. However, specific rules for using nutrient content claims assures the consumer the claim is meaningful in a real diet.

Some food labels will have health claims. These are sentences that remind the consumer that certain nutrients affect the development of specific diseases. The claims are monitored by government scientists. They must be true and they must be related to some disease that is important to Americans. There are currently (1994) seven different types of health claims allowed:

- high calcium levels may prevent osteoporosis (a loss of calcium from bones)
- low sodium levels may reduce high blood pressure
- low fat levels may decrease problems with cardiovascular disease
- low fat levels may reduce the risks of some types of cancer
- high levels of dietary fiber may reduce the risks of some types of cancer
- high levels of dietary fiber may decrease problems with cardiovascular disease
- high levels of folic acid may reduce risks of some types of birth defects (neural tube defects)

Foods that make health claims must be "high" (calcium, fiber or folic acid) or "low" (fat, sodium) in the specific nutrient. In addition, the levels of other nutrients in the food are considered. For example, whole milk is high in calcium, but it is also a significant source of fat and cholesterol, so it cannot make a health claim. Skim milk on the other hand, may make calcium and fat claims. Again, the rules are complicated, but they assure the consumer that the food making a health claim really is part of a healthy diet.

Summary

The food label is designed to communicate to the consumer. There are four required parts of the food label: 1) the name of the food; 2) the amount of the food in the container; 3) the name of the manufacturer; 4) the ingredient list. Almost all foods also require a Nutrition Facts Panel. Some foods may also have nutrient content or health claims. These parts of the food label are carefully controlled.

Nutritional requirements are illustrated by the Food Pyramid. This graphic representation of the five food groups is very helpful in choosing an adequate diet. However, more complex foods that contain many food groups are difficult to place on the Pyramid. The food label reports a Percent Daily Value that is very helpful.

Proper nutrition depends on the individual. Specific recommendations can be found by combining information from several sources including the food label. Fortunately, by using variety and moderation in food choices, most people do not have to become professional nutritionists to eat a balanced diet.

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Lesson 3:
Nutritional Value of Beverages

Have you ever heard of "empty calories." These are foods or drinks that provide calories in your diet but supply very few or no nutrients. Yet many beverages do supply nutrients, as this lesson will explain.

Nutritional Benefits of Beverages

Beverages are an important part of the human diet. The most important function of a beverage is to supply necessary fluids for the body. Depending on the specific beverage, some supply carbohydrates, protein, fat, vitamins, and or minerals. Also, beverages supply the fluid necessary for normal metabolism.

How the Body Utilizes Beverages

Since the human body is 60 percent water, water is very important in the diet and to a person's health. Dehydration symptoms appear when a 5-10 percent reduction in the water balance occurs, accompanied by thirst, weakness, and mental confusion. Water has four major functions in the body: a medium for carrying nutrients within body fluids; a solvent for organic and inorganic chemicals necessary for life, and a medium for which the chemical reactions can be dispersed in; a carrier for the nitrogenous wastes generated by cellular metabolism; and as a control and maintainer of body temperature.

Of course the body will utilize the other nutrients that may be found in the beverage similarly to how it utilizes nutrients found in food. Generally, nutrients are absorbed through the intestinal wall into the bloodstream, with the exception of molecules of aspirin and alcohol which are absorbed through the stomach wall.

Alcohol is metabolized differently than most nutrients. It is absorbed in the stomach where it goes directly to the liver. Alcohol is broken down to its components and used like other nutrients. However, too much alcohol can overwork the liver, causing it to incompletely break down other nutrients. An overworked liver will convert other components to fat. This fat deposits in the liver, causing many other problems. Ultimately, the liver can stop functioning properly. This disease, called cirrhosis, is one of the top ten causes of death in the U.S.

Nutritional Qualities of Common Beverages

Milk is very nutritious as it supplies protein, carbohydrates, fat, vitamins, minerals, and water.

Carbonated soft drinks, the leading beverage in terms of consumption, provide water and carbohydrates. Some provide minerals, like sodium. Others contain fruit juice, which supplies some vitamins. In general, carbonated beverages contribute very few nutrients and should be consumed in moderation. Excessive consumption of these beverages may interfere with the body's ability to absorb calcium.

Coffee and tea, unless they include cream or sugar, supply no nutrients except water.

Fruit juices provide water, carbohydrates, vitamins, and minerals. Some may provide small amounts of protein.

Nature's Almost Perfect Food

Why is milk called nature's most nearly perfect food? It is nature's most perfect food because it is naturally in a liquid state and is easily consumed by young and old alike. Milk protein is of premium quality, including all essential amino acids. The nutritive value of vegetable proteins are substantially increased when milk is consumed with them. The two primary proteins in milk are casein and lactalbumin.

Lactose is the principal carbohydrate found in milk. Milk is the only significant source of lactose in nature. Lactose may have a special role in the growth and development of the central nervous system. Lactose stimulates the growth of microorganisms in the intestine, which produce organic acids and synthesize many B-complex vitamins. Lactose enhances absorption of calcium, phosphorus, and magnesium in the intestine.

Milk fat contains a relatively high amount of short-chain fatty acids, which are easily digested by humans. Some nutritionists believe these short chain fatty acids do not contribute to heart disease like the longer chain saturated fatty acids found in other animal fats. Milk also contains unsaturated, essential fatty acids.

The major minerals found in milk include calcium, phosphorus, potassium, chlorine, sodium, sulfur, and magnesium. Milk is not a very good source of iron or copper in the diet.

Milk contains all known vitamins and is an especially good source of riboflavin and other B vitamins. Vitamins A and D are usually added to milk as a supplement. Vitamin C, ascorbic acid, is the only vitamin needed for good health that milk cannot completely satisfy.

Milk is not a particularly good source of vitamin C, principally because it is pasteurized to prevent the spread of disease causing microorganisms.

Summary

Beverages play a vital role in the diet. Water balance is maintained in the body by consuming water and other beverages.

Body fluid is a medium for carrying nutrients, a solvent for organic and inorganic chemicals, a carrier of waste products, and a control for body temperature. Common beverages provide carbohydrates, protein, fat, minerals, and vitamins depending on the particular beverage. Milk is considered nature's most nearly perfect food. It contains most of the necessary nutrients in high quality form.

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Lesson 4:
Relationship Between Diet and Health

Food labels are highlighted with eye-catching slogans such as: "contains no cholesterol" or "high fiber" or "fat-free." Do these influence you? Are you conscious about your diet? Whether you are or are not, you can be sure that your diet does influence your health. This lesson highlights a few of today's issues.

Cholesterol

Cholesterol is a popular topic of conversation. Do you know what it really is? How does it work? Is it true that the body actually makes cholesterol? What are HDL and LDL?

Cholesterol is a waxy, fat-like substance necessary for building membranes, particularly in the brain and nervous system. Cholesterol plays a vital role in bile synthesis and in the production of adrenal and sex hormones. A derivative of cholesterol found in the skin is converted by sunlight to vitamin D. If insufficient amounts of cholesterol are in a person's diet, the liver will produce cholesterol.

Cholesterol found in the blood is called serum cholesterol, or blood cholesterol. Dietary cholesterol is present in foods. Cholesterol is only found in foods of animal origin, like eggs, meat, fish, poultry and cheese. Dietary cholesterol is spread throughout the food, it is not isolated in the skin or fat portions.

Blood cholesterol levels are affected by many factors including diet, heredity, age, and gender. Blood cholesterol levels are measured in milligrams per deciliter. Standards are set as: less than 200 mg/dl - desirable; 200-239 mg/dl - borderline; greater than 240 mg/dl - high. A high blood cholesterol level is a major risk factor for a person developing coronary heart disease. Cholesterol is carried in the blood by molecules called lipoproteins. Low-Density Lipoprotein (LDL) is referred to as "bad" cholesterol because it carries cholesterol to the tissues. High-Density Lipoprotein (HDL) is referred to as "good" cholesterol because it is transported from the tissues to the liver for elimination.

Cholesterol is often discussed in connection with dietary fat, even though they are two different substances. A diet that is high in total fats and saturated fats will tend to increase blood cholesterol levels. The connection between dietary cholesterol and blood cholesterol levels is less certain. This area of nutrition is changing rapidly as we learn more about the role of diet in health.

Fats

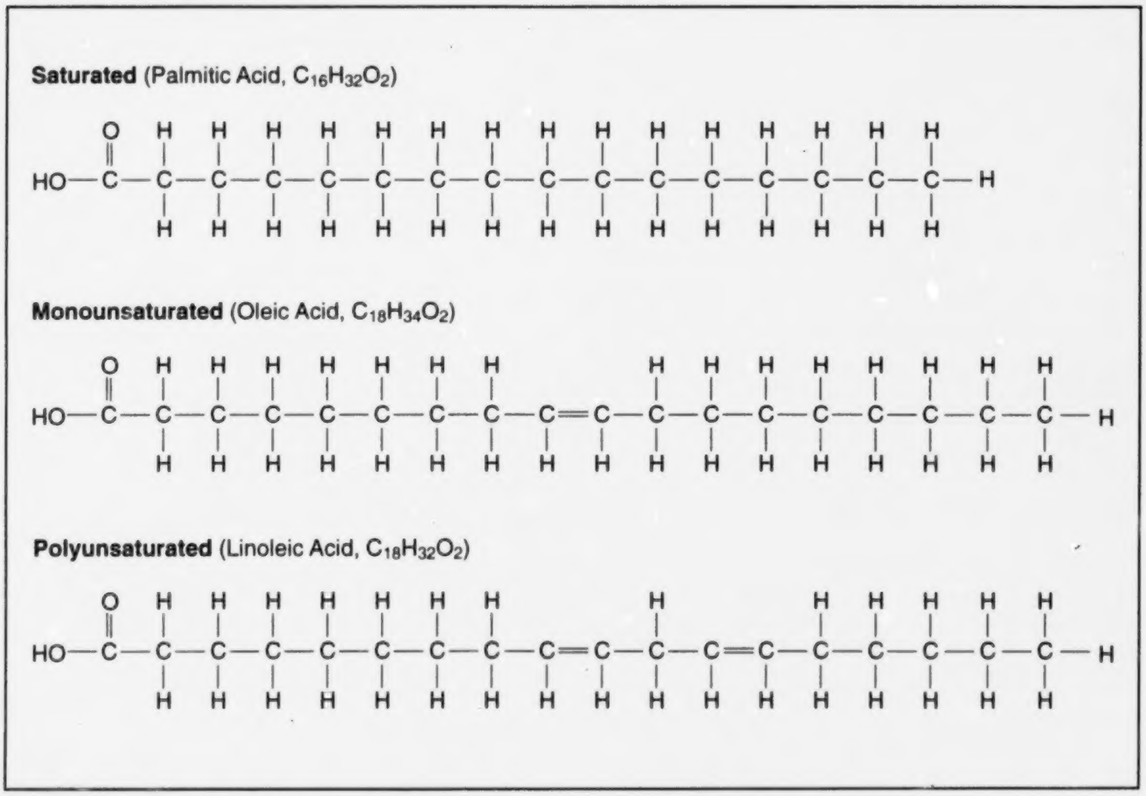
Fats in food are responsible for many of the flavors, textures, and aromas we find desirable. Fat also influences the degree of fullness and satisfaction (satiety) of a meal. Fats are the most concentrated source of food energy, supplying nine Calories per gram. They are needed to transport and absorb the fat-soluble vitamins: A, D, E, and K.

Fats are composed of fatty acids, which can be classified as saturated, monounsaturated, or polyunsaturated. Three fatty acids attached to a glycerol molecule constitute a triglyceride. Most triglycerides have a chemical structure composed of a long, straight chain of carbon atoms (Figure 4.1). If the carbon atoms are linked together by single bonds, the molecule is a saturated fatty acid. If one double bond connecting carbon atoms is present, it is a monounsaturated fatty acid. If two or more double bonds are present, the fatty acid is polyunsaturated. Their chemical structure determines their behavior in your digestive system and in your body cells.

Saturated fatty acids predominantly come from animal sources and coconut, palm, palm kernel, and vegetable oils. Bear in mind that fats and oils contain many types of fatty acids. They are classified according to their predominant acid type. Because saturated fatty acids can raise blood cholesterol levels, it is recommended that they compose 1/3 or less of total fat intake.

Monounsaturated fatty acids are found in animal and plant fats, especially in olive, canola, and peanut oils. These may help lower blood cholesterol levels. Recommendations call for 1/3 or less of total fat intake to be supplied by monounsaturated fatty acids.

Figure 4.1 - Fatty Acids



Saturated (Palmitic Acid, $C_{16}H_{32}O_2$)

Monounsaturated (Oleic Acid, $C_{18}H_{34}O_2$)

Polyunsaturated (Linoleic Acid, $C_{18}H_{32}O_2$)

Polyunsaturated fatty acids come from sunflower, safflower, corn, sesame, and soybean oils. These can help lower blood cholesterol. Linoleic acid, which is one example of a polyunsaturated fatty acid, is an essential fatty acid needed for normal growth.

The proportion of saturated to unsaturated fatty acids give fats and oils their individual physical properties. Fats containing more saturated than unsaturated fatty acids are typically solid at room temperature. Fats which are more unsaturated than saturated are typically liquid at room temperature. The exceptions are the mostly saturated palm and coconut oils which are liquids at room temperature.

It is recommended that fats should contribute no more than 30 percent of total calories in your diet.

Fiber and Health

It has long been recognized that fiber contributes to a healthy intestine. Cellulose, pectins, lignin, and other plant substances that are not readily digested, constitute fiber. Fiber holds water, loosens the stool, and decreases the stool transit time through the large intestine.

Research also has shown that adequate dietary fiber may lower serum cholesterol, decrease the incidence of colon cancer, and lower the insulin requirements of diabetics. Fiber from different sources varies in its proportion of the different indigestible components and is not equal in its physiological effect. Grinding and other processes also influence fiber's effectiveness. Excessive fiber may bind minerals and make them unavailable for absorption.

Health Issues and Nutrition

One of the privileges of living in America is the vast supply of high quality, low-cost foods. Americans have a longer life expectancy than many other countries. One of the reasons for this is the availability of good nutritious foods. However, the availability of low fiber, high fat foods contributes to poor health among Americans. Most nutritional diseases in the United States are diseases of excess, but nutritional deficiencies do occur. Many health issues are tied to nutrition.

Anorexia is a disease where the individual refuses to eat, even though they are starving.

Bulimia is a disease characterized by a person vomiting food before it provides nourishment. Bulimia results in starvation and other physiological complications.

Diverticulitis is the condition of an inflamed colon, which can be initiated by certain foods as well as being treated with fibrous foods.

Heart disease is characterized by problems associated with blood circulation. Consumption of high levels of fat seem to increase the risk of developing this problem.

Malnourishment is defined as the lack of, or an insufficient amount of an essential nutrient. There are several diseases caused from malnourishment. Most vitamins and minerals are associated with some nutritional deficiency.

Obesity is almost the opposite of starvation. Obesity occurs when more calories are ingested than spent. An accumulation of calories leads to fat deposits and extra weight. Obesity is a contributing factor to many other diseases including heart disease, arthritis, and diabetes.

Starvation is a condition of being without food for an extended period of time. The body's energy stores are also depleted and the body begins to break down in an attempt to supply energy to the brain, heart, and lungs.

Ulcers are lesions in the stomach lining. Ulcers can be caused by specific foods and treated by specific foods.

Beri-beri is a thiamin deficiency. Osteoporosis is a softening of the bone tissue linked to a calcium deficiency. Night blindness is a vitamin A (carotene) deficiency. Neuritis is a thiamin deficiency. Photophobia is caused by a riboflavin shortage. Anemia is caused by a lack of iron or vitamin B_{12}. Pellagra is caused by a lack of niacin. Scurvy is caused by a shortage of vitamin C. Rickets is a defective bone formation caused by a vitamin D deficiency. And hemophilia is caused by a vitamin K shortage.

A final health-related issue affected by nutrition is a person's recovery time following an illness or surgery. People in good health, who have a balanced diet and lifestyle, require less recovery time.

Health Problems Can be Minimized by Nutrition

The human body is an intricate creation. Its physiological functions depend on hundreds of factors. One of the most important factors is proper nutrition. A balanced diet accompanied by sufficient regular exercise is a great start. Eating habits that follow the Recommended Dietary Allowance (RDA's) and are appropriate in caloric intake in order to remain in weight range for age and height are highly encouraged. And finally, if diet modification is recommended to correct or prevent a health problem, following a doctor's or dietician's suggestions is recommended.

Summary

There is a direct relationship between diet and health. Issues about cholesterol, fat composition, grams of fat, and others are popular topics. Cholesterol is a necessary part of normal health. The type and amount consumed can be controlled by what a person eats. Fats are either saturated, monounsaturated, or polyunsaturated depending on the number of double bonds between carbon atoms. A balance of all three types in the diet is recommended. Fiber influences intestinal health and is therefore very important. There are many diseases related to dietary deficiencies, imbalances, and over indulgence. Many of these health problems can be minimized by a balanced diet that includes an appropriate caloric intake.

Credits

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